INNOVATIVE APPROACHES TO TEACHING AND LEARNING AGRICULTURAL SCIENCE AND EDUCATION: ENGAGING STUDENTS IN HANDS-ON LEARNING. A CASE STUDY OF UNIVERSITY OF BENIN

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BEING A PROJECT SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL / FINE AND APPLIED ARTS EDUCATION , FACULTY OF VOCATIONAL AND TECHNICAL EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCES DEGREE B.Sc.(Ed) IN AGRICULTURAL EDUCATION OF UNIVERSITY OF BENIN, BENIN CITY.

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CERTIFICATION

We the undersigned hereby certify that this work was carried out by Blessing Olohigbe AKPATA with the Matriculation Number **EDU2006038** from the Department of Agricultural / Fine and Applied Arts Education, University of Benin, Benin City, Nigeria In partial fulfilment of the requirements for the award of Bachelor of Science Degree B.Sc.(Ed) in Agricultural Education of University of Benin, Benin City.

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DEDICATION

This study is dedicated to the Almighty God for His divine mercy, love, wisdom, and understanding, strength and assistance granted throughout this study.

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ABSTRACT

The study employs a descriptive survey research design, with a population of 141 students from the Department of Vocational and Technical Education. A simple random sampling technique was used to select 71 respondents. Data were collected through structured questionnaires, validated by experts, and tested for reliability using Cronbach's Alpha, yielding a coefficient of 0.73. The analysis was conducted using mean and standard deviation, with a threshold of 2.5 for acceptance of responses.

The findings highlight that digital tools, field-based activities, technology integration, and hands-on laboratory and farm practices significantly enhance student engagement, cognitive development, and skill acquisition. Despite these benefits, challenges such as technological adaptation difficulties, limited real-world application, and inadequate infrastructure hinder the full adoption of innovative methods. To address these barriers, the study recommends collaborations with agribusinesses, improved access to modern equipment, training workshops for educators, and diversified instructional methods.

This research underscores the necessity of transforming agricultural education through experiential learning to produce graduates equipped for the evolving demands of the agricultural sector. The findings provide a foundation for curriculum development, policy adjustments and institutional reforms aimed at fostering an interactive and practical learning environment in agricultural science and education.

CHAPTER ONE

INTRODUCTION

Background to the Study

Agriculture holds a great deal of opportunities as it provides food security to the individuals involved. It plays a vital role in the economy and food security of many countries and nations. Agricultural science and education creates that platform that readily inculcates the knowledge and prerequisite into students to enable them practice agriculture. The goal is to furnish students with requisite skills and understanding vital for success across diverse sectors of the agricultural industry, spanning farming, agribusiness, agricultural engineering and natural resource management (Jackson & Murdock, 2020). There are however various innovative approaches to teaching and learning Agricultural science and education.

Innovative approaches are creative yet flexible and collaborative methods that introduce new ideas, technologies or techniques to enhance teaching, learning and student participation and engagement in educational activities. In recent years, there has been a shift towards innovative approaches to agricultural education that focus on active learning and problem-solving.These approaches have been shown to improve student engagement, knowledge retention, and critical thinking skills. These approaches includes: Participatory learning action (Pla), problem based learning (pbl), the use of simulations, flipped classrooms, the integration and infusion of technology, service-learning projects,

gamification, micro-credentials, adoption of innovative agricultural science and education programs and hands-on learning. Participatory Learning and Action (PLA) which can be an effective approach for engaging learners in the process of planning, implementing, and reflecting on their own learning experiences (Pretty & Chambers, 1993), Problem-based Learning (PBL) which can help learners develop problem-solving skills and critical thinking abilities by presenting them with complex, real-world problems (Barrows, 1996), The use of simulations, such as farm business simulations, can help learners understand the complexities of farm management and make informed decisions (Cromley & Schultz, 2000), Flipped classrooms, where students watch lectures at home and work on problems in class, can be an effective way to engage learners and improve their understanding of complex concepts (Ayersman et al., 2014), The integration and infusion of technology, such as online learning platforms, virtual reality, artificial intelligence and mobile apps, can help learners access information and resources more easily and learn at their own pace (Hsu et al., 2015), Service-learning projects, where students work on community-based projects related to agriculture, can help learners apply their knowledge in real-world contexts (Saunders et al., 2013), Gamification, or the use of game-based elements in learning, can be an effective way to engage learners and motivate them to learn (Hamari et al., 2014), Micro-credentials which includes providing students with short-term, skill-based courses that can be tailored to their individual needs and interests (Taylor and Wainman, 2022), Adoption of innovative and strategic agricultural science

and education programs which enhances forward-thinking approach to teaching and learning in the field of agriculture (Fitterer and Holm, 2023) and Hands-on learning activities, such as field trips, lab experiments, maker spaces and experiential learning can help learners develop practical skills and better understand complex agricultural concepts (Allen & Yen, 2014).

Hands-on learning is a method of education that involves students actively engaging in the learning process, often through practical experiences and activities. Hands-on learning approach leads to higher levels of student engagement, improved problem-solving skills, cognitive development and a deeper understanding of the subject matter (Beswick & Gilley, 2021). Experiential learning, problem solving skills, practical skills and cognitive development are the major features of hands-on learning. Experiential learning involves learning through experience, and is often considered a key component of hands-on learning. (Stern & Empson, 2009), Problem-solving skills: Hands-on learning helps students develop problem-solving skills by requiring them to apply their knowledge in real-world situations. (Chinnery, 2018), Cognitive development: Hands-on learning has been shown to stimulate cognitive development and enhance student learning outcomes in a variety of educational settings. Hands-on learning activities include field trips, field works, lab experiments, service learning projects, simulations, maker spaces, entrepreneurship programs, hackathons, internship and industrial training.

Engaging students in hands-on learning experience broadens and widens their horizons and enabling them fit into the world of work. Hands-on learning exposes students to the practical aspects of agricultural science that they were taught in school, allowing them to apply their knowledge in a practical context and develop a deeper understanding of the subject and grants them easy navigation into the real world of work (Huang and Parsons, 2021). The potential for these innovative approaches is to transform agricultural education and prepare students for the demands of 21st-century agriculture (Zhang et al. 2022). Hands-on learning has increased students' self-confidence, communication skills, and teamwork abilities (Szafir et al. 2022).

There is need to invest in practical and innovative approaches to teaching and learning agricultural science and education as it engages students in hands-on learning because the traditional and theoritical methods of teaching agricultural science and education are outdated and cannot be dependent upon to sharpen students for the competitiveness, complexities and challenges present in the modern world of work. These traditional approaches focus too much on knowledge acquisition and not enough on practical skills and critical thinking (Fitterer and Holm, 2023). Traditional methods of teaching and learning, which focus on knowledge transmission and memorization, are not sufficient to prepare students for the complex and rapidly changing demands of the agricultural industry, This suggests that innovative approaches, such as hands-on learning,

experiential learning, and collaborative learning, can help students develop the practical skills and critical thinking abilities that are necessary for success in the modern agricultural industry (Huang and Parsons, 2021). Many employers in the agricultural industry are looking for employees who have practical skills and experience, rather than just theoretical knowledge but universities uses approaches which focus on knowledge transmission and memorization which have been found to be inadequate in preparing students for these challenges (Huang and Parsons 2021). New technologies, such as virtual reality and the Internet of things, have the potential to revolutionize agricultural education by providing students with immersive and interactive learning experiences that enables them revolve with the trends as they come (Zhang, Li, and Wang 2022).

One significant effect of adopting innovative approaches to teaching and learning agricultural science and education engaging students in hands-on learning is improved student engagement and motivation: Hands-on learning activities can be more engaging and motivating for students, leading to higher levels of student engagement and enjoyment (Huang and Parsons, 2021). Students tend to learn faster and easier when they are actively involved in the process of learning and this comes by manually participating in the process of experience (Allen and Yen, 2014).

Another effect is Increased knowledge retention and problem-solving skills: Hands-on learning experiences can help students develop a deeper understanding of agricultural

concepts and improve their problem-solving skills (Beswick and Gilley, 2021). Innovative approaches to teaching and learning in agriculture can help to stimulate cognitive development in students by promoting critical thinking, problem-solving, and creativity. (Kim, D., Kang, H., & Song, B, 2022). Furthermore, adoption of innovative approaches to teaching and learning agricultural science and education sharpens the cognitive ability of student equipping the students with necessary tools and skills to achieving an enviable and successful career path in agriculture. Therefore, this study seeks to identify the need to incorporate innovative approaches to teaching and learning agricultural science and education in University of Benin.

STATEMENT OF PROBLEM

Despite the technicalities involved in teaching and learning agricultural science and education, the traditional method of teaching is still used to transmit or transfer knowledge to the students. This traditional theoretical methods of teaching agricultural science and education have shown to be inadequate and has brought about low and limited engagements of students, lack of critical and cognitive thinking skills, limited technological and inability in preparing students for the complexities of modern agriculture and the changing demands of the agricultural industry.The innovative approaches to teaching and learning agricultural science and education which includes participatory learning action, problem based learning, the use of simulations,flipped classrooms, gamifications, modern technology such as artificial intelligence, virtual reality, mobile

apps and Google classrooms, micro-credentials and hands on learning, and modern techniques in agriculture like precision farming, hydroponics and the likes. These will impact not only in encouraging the students to learn agriculture as a topic but also will be able to make them to have the technical skill to be able to practice agriculture which will also help in food production and food security.The major reason of this study is to fill the lacuna that comes with teaching agriculture in obsolete manner full of drudgery and more of therories without practical. Given the critical role of agricultural science and education in creation of job opportunities, student preparation and creativity and national development, food security and food production,it is imperative to understand and implement innovative approaches to teaching and learning agricultual science and education thereby engaging students in hands-on learning in the University of Benin hence the need for this study.

RESEARCH QUESTIONS

The following research questions were raised to guide this study

1. What are the innovatve approaches to teaching and learning agricultural science and education at the University of Benin?

2. How does engaging students in hands-on learning enhance the learning of agricultural science and education at the University of Benin?

3. How can innovative appraoches be integrated into existing curriculum and pedagogy of agricultural science and education at the University of Benin?

4. What are the most effective innovative approaches for teaching and learning agricultural science and education at the University of Benin?

5. What are the barriers and challenges faced by students who are learning agricultural science and education traditionally and how can innovative approaches in agricultural science and education be implemented at the University of Benin?

6. What strategies and interventions can be implemented to overcome the barriers of studying agricultural science and education traditionally at the University of Benin?

PURPOSE OF STUDY

The main purpose of this study is to encourage the incorporations of innovative approaches to teaching and learning agricultural science and education thereby engaging students in hands-on learning in the University of Benin, the specific purposes of this study are to;

1. Find out the innovative approaches to teaching and learning agricultural science and education at the University of Benin.

2. Observe the outcome of how engaging students in hands-on learning enhances the learning of agricultural science and education at the University of Benin.

3. Find out how innovative approaches can be integrated into the curriculum and pedagogy of agricultural science and education at the University of Benin.

4. Determine the most effective innovative approach for teaching and learning agricultural science and education at the University of Benin.

5. Ascertain the startegies and interventions that can be implemented to overcoming and addressing the barriers of studying agricultural science and education traditionally at the University of Benin.

SIGNIFICANCE OF THE STUDY

This study on Innovative approaches to teaching and learning agricultural science and education,engaging students in hands-on learning in the University of Benin would be of great Benin to University of Benin Administrators, Students and prospective students, Government and Policy makers, Agricultural Industries and Employers and agric sector.

Understanding the usefulness of innovative and modern approaches to teaching and learning agricultural science and education can help admistrators to tailor the strategies of enhancing the programs relevance and sustainability and Insights from the study can help to better meet the needs and aspirations of students.

Prospective students can make more informed decisions and be well aware of the effective methods of teaching based on the understanding of the barriers and opportunities identified in the study and Current students may benefit from targetted support services and

interventions aimed at addressing the traditional challenges of teaching and learning agricultural science and education thereby improving retention rate, overall academic success and hands-on training.

Policymakers can use the study findings to inform the development of policies and initiatives aimed at promoting access to agricultural science and education particularly for underrepresented groups. By addressing the barriers surrounding the Innovative approaches, policymakers can contribute to the development of a skilled workforce in the agricultural sector, thereby fostering economic growth, food security and food production.

This study can provide valuable insights into the standards to look out for which influences the supply of skilled labor in the agricultural sector, helping employers better understand the challenges and opportunities in recruiting and retaining qualified personnel.

This study can also contribute to the development of a more diverse and skilled workforce,which is essential for Innovation and competitiveness in the agricultural industry.

The study of innovative approaches to teaching and learning agricultural science and education to the agric sector is that they can help to improve agricultural practices, increase agricultural productivity, and support the growth and development of the agricultural sector.Innovative approaches to teaching and learning agricultural science and education

can provide farmers and agricultural workers with the skills and knowledge they need to make better use of modern technologies, to adopt more sustainable and efficient farming practices, and to develop new products and markets.

SCOPE AND DELIMITATION OF THE STUDY

The scope of this study is to incorporate innovative approaches into teaching and learning agricultural science and education thereby engaging students in hands-on learning in the University of Benin. This study is delimited to undergraduate Students in University of Benin, Benin City, Edo state.

DEFINITION OF TERMS

Agricultural science and education: Agricultural science and education is an interdisciplinary field that combines elements of agricultural science, education, and other related disciplines to support the development of the agricultural sector while offering a combination of theoritical knowledge and practical skills.

Innovative Approaches: Innovative approaches are new or creative methods, strategies, or techniques that are used to address a problem or challenge. They are often characterized by the use of new technologies, the adoption of new or unconventional methods, or the application of existing knowledge in new or creative ways.

Hands-on learning: Hands-on learning is an educational approach that emphasizes the use of practical, experiential, and interactive activities to support learning.Hands-on learning involves students actively engaging with the subject matter, rather than simply listening to lectures or reading about it.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviewed the related literature of the study under the following subheadings:

• Theoretical Framework

• Concept of Agriculturl Science and Education

• Innovative Approaches to teaching and learning Agricultural Science and Education

• Engaging students in hands-on learning

• Barriers and Challenges Faced by Students

• Strategies and Interventions to address the barriers of Teaching and Learning Agricultural science and Education

• Review of Related Empirical Studies

• Summary of Reviewed Literature

Theoretical Framework

This study on Innovative Approaches to Teaching and Learning Agricultural Science and Education Engaging Students in Hands-on Learning in University of Benin is underpinned to the theory of constructivism. The theory of constructivism was first introduced by Swiss developmental psychologist Jean Piaget (1896-1980) but was later

expanded on by an American philosopher John Dewey (1859-1952) emphasizing the importance of hands-on, experiential learning in schools. This theory offers a compelling framework for understanding the Innovative Approaches to Teaching and Learning Agricultural Science and Education Engaging Students in hands-on learning at the University of Benin. This theory posits that learning is an active and social process in which learners construct knowledge through their own experiences and interactions with others. This theory aligns well with hands-on learning, which involves active engagement with materials, concepts, participation and collaboration with other learners. Constructivism emphasizes the importance of real-world experiences, problem-solving, and reflection in learning, which are key components of hands-on learning in agricultural science and education.

Dewey's theory is particularly suitable for this study due to several key reasons.

Firstly, it emphasizes the importance of real-world experiences with problem solving skills and reflection in learning, which are the key components for incorporating hands-on learning and innovative approaches to teaching and learning agricultural science and education. This resonates with the fact that the theoretical and traditional method of teaching does not necessarily equip the students with the intellectual capability and cognitive endowment needed to function in the world of work which follows contemporary trend with time. This aligns with the notion that experience is the best

teacher and when student are involved in hands-on training and other approaches, they are equipped to possess the criteria needed to be useful in the world of work.

The theory of Constructivism provides a strong theoretical foundation for the development of innovative approaches to teaching and learning agricultural science and education. According to this theory, students learn best when they are actively engaged in the learning process, reflecting on their experiences, and constructing meaning from their interactions with the world. Moreover, this theory suggests that hands-on learning experiences, such as gardening, animal husbandry, soil science, and food science, are essential for fostering student engagement and understanding. By actively participating in these activities, students can make connections between theory and practice, deepen their understanding of agricultural science concepts, and develop practical skills that are relevant to their lives.

The theory of Constructivism also highlights the importance of collaboration in learning. In agricultural science and education, hands-on learning activities can provide opportunities for students to work together, exchange ideas, and solve problems. For example, students can collaborate on a class project to design a sustainable garden, or they can work in teams to care for livestock or conduct soil analyses. Constructivism emphasizes the importance of reflection and meaning making. After completing hands-on learning activities, students can reflect on their experiences, discuss what they have

learned with others, and apply their knowledge to new situations. Constructivism also suggests that learning should be individualized to meet the needs and interests of each student. In agricultural science and education, hands-on learning activities can be tailored to the specific interests of individual students, allowing them to explore the topics and projects that most interest them.

Finally, constructivism emphasizes the importance of authenticity in learning. Hands-on learning in agricultural science and education can provide students with opportunities to engage with real-world problems, such as food insecurity, climate change, and sustainability, which can inspire them to make a positive impact in the world. This resonates with the study's objective of understanding how innovative approaches and engaging students in hands-on training can impact on the students learning agricultural science and education.

Concept of Agricultural Science and Education

The concept of agricultural science revolves around the multidisciplinary study of various aspects of agriculture, including crop production, animal husbandry, soil science, and agricultural economics. It involves research into agricultural practices to enhance productivity and sustainability. (Smith, 2010). Agricultural science and education is a broad field that encompasses a wide range of topics, including plant and animal science, soil science, horticulture, food science, and environmental science. These fields are

essential for understanding and addressing global challenges, such as food insecurity, climate change, and environmental degradation. Agricultural science and education represent a vital component of educational systems worldwide, offering students specialized training and hands-on in various aspects of agriculture and related fields (Smith, 2028). These programs aim to prepare individuals for careers in the teaching profession, agriculture, agribusiness, natural resource management and related industries by providing practical skills, theoretical knowledge and experiential learning opportunities (Jones & Brown, 2020).

Agricultural science and education play a vital role in shaping the knowledge, skills, and attitudes necessary for sustainable agriculture, food security, and rural development. As an interdisciplinary field, agricultural science draws from biological, environmental, economic, and social sciences to address complex issues related to agriculture, food systems, and resource management. Future farmers and agricultural professionals must be equipped with the knowledge and skills to address the environmental and social challenges facing the agricultural sector. This includes understanding the principles of agro ecology, sustainable land management, and resource conservation, as well as developing the capacity to innovate and adapt to changing circumstances (Tilman et al., 2019). Agricultural education is essential for empowering rural communities and promoting inclusive development by providing individuals with the skills to engage in

productive agricultural activities, agricultural education contributes to poverty alleviation and economic growth in rural areas (FAO, 2017).

Agricultural science and education seeks to meet the need to update agricultural curricula to reflect the changing nature of the agricultural sector. This includes incorporating emerging technologies such as precision agriculture, biotechnology, and digital agriculture into educational programs (Basso & Antle, 2020). Many students and teachers lack access to the latest research findings and technologies, limiting their ability to improve productivity and sustainability (Sanginga, 2015). There is also need to strengthen the capacity of agricultural educators to deliver high-quality instruction that meets the needs of diverse learners (Bruening & Radhakrishna, 2014).

The increasing global demand for food, coupled with the need for more sustainable agricultural practices, creates a growing demand for skilled agricultural professionals who can develop and implement innovative solutions which agricultural science and education equips their students with (Alston & Pardey, 2020). One of the key principles underlying agricultural programs is the concept of experiential learning which emphasizes active engagement, practical application and reflection (Brown & Garcia, 2018).

Agricultural education plays a crucial role in promoting sustainable agriculture by teaching students at all levels about agricultural principles and practices. It helps develop the knowledge and skills needed to work in the agricultural industry. (National Agricultural Education Association, 2018). Agricultural education also focuses on promoting food security, which refers to the availability of a secure and reliable food supply for all people at all times. By educating students about food production and distribution, agricultural education programs contribute to ensuring access to nutritious and affordable food. (Food and Agriculture Organization of the United Nations, 2017). Agricultural education is particularly essential as many people rely on agriculture for their livelihoods. By equipping students with the necessary knowledge and skills in agriculture, these programs contribute to sustainable farming practices and food security. (Darnhofer et al., 2010).

The concept of agricultural science and education encompasses a diverse range of educational initiatives including formal classroom instruction, vocational training, field-based experiential learning, agricultural extension services, and community-based programs aimed at improving agricultural practices and sustainability (Philip et al., 2008). Through internships, apprenticeships, field trips and laboratory exercises, students gain first-hand experience working in diverse agricultural settings including farms, ranches, agribusiness, research institutions and government agencies. (Clark et al., 2019).

This hands-on learning allows students to develop essential skills crop production, livestock management, soil conservation, pest control, agricultural mechanization and value adding processing while also fostering critical thinking, problem solving, teamwork and communication skills.(White, 2020).

Moreover, agricultural science and education often incorporates other interdisciplinary approaches such as biology, chemistry, environmental science, economics, business management and technology. (Robinson & Lee, 2019). This interdisciplinary prospective equips students with the versatility and adaptability needed to address emerging challlenges and seize opportunities in a rapidly evolving agricultural landscape. (Thomas & Martinez, 2018).

Agricultural science and education prioritizes sustainable practices that minimize environmental impact while maintaining or improving yields. This involves teaching sustainable land use, water conservation, soil health, and biodiversity preservation (Altieri, 2018). It aims to enhance the livelihoods of rural populations by providing them with the knowledge to improve productivity and engage in profitable agricultural practices. It also seeks to empower students with technical skills to innovate and adapt to changing conditions (FAO, 2017). Modern agricultural science and education also teaches students how to manage resources such as water, soil, and biodiversity in a way that ensures sustainability while optimizing output (FAO, 2021).

The integration of modern technologies such as precision agriculture, biotechnology, and digital tools in farming is a key focus. Agricultural science and education prioritizes preparing students to adopt and apply new technologies that improve efficiency and sustainability (Basso & Antle, 2020). The advancements in agricultural science have transformed traditional farming methods, allowing for more efficient, sustainable, and productive approaches to farming (Zhang, Wang, & Wang, 2019). By combining technical expertise with broader knowledge and skills, agricultural science and education prepares students to navigate the complex interconnections between agriculture and various sectors, including food systems, natural resource management, renewable energy, biotechnology and international trade. (Davis, 2021).

Agricultural science and education prioritizes teaching adaptive strategies to mitigate the effects of climate change on agricultural systems. This includes promoting climate-smart agriculture, resource-efficient farming, and resilience-building techniques (Lipper et al., 2014). A priority of agricultural science and education is to provide access to education and resources for marginalized groups, including women and smallholder farmers, to ensure inclusive development and equal opportunities in the agricultural sector (Quisumbing & Pandolfelli, 2010).

Agricultural science equips future farmers with knowledge about how changing weather patterns, soil degradation, and water scarcity can impact farming, as well as how they can

adapt to these changes (Altieri, 2018). For instance, students of agricultural science and education are taught to use precision agriculture techniques, which involve the use of data and technology to optimize field-level management regarding crop farming. This includes the utilization of sensors, drones, and geographic information systems (GIS) to monitor crops and apply resources such as fertilizers and pesticides precisely where and when they are needed (Zhang et al., 2019). These techniques not only improve efficiency but also help in reducing environmental impact (Zhang et al., 2019).

Agricultural science and education provides the technical knowledge necessary for modern farming, education is what transforms that knowledge into actionable, real-world practices. Agricultural science and education, whether through formal schooling, extension services, or vocational training, equips students with the skills needed to apply scientific principles on their farms effectively (Van den Ban & Hawkins, 1996). Educational institutions, such as agricultural universities and technical schools, play a crucial role in this process. These institutions offer specialized courses in agronomy, animal husbandry, agroforestry, soil science, and agricultural economics, among others. This formal education provides students with a strong foundation in both the theory and practical aspect of farming (Rivera & Alex, 2004). Moreover, educational programs often involve practical, hands-on training through internships, farm visits, and experimental plots, allowing students to apply classroom knowledge in real-world scenarios (Rivera &

Alex, 2004). By teaching students how to analyze data, make informed decisions, and employ innovative techniques, agricultural education empowers future farmers to not only maintain but also improve productivity and sustainability on their farms (Rivera & Alex, 2004).

Moreover, agricultural education fosters entrepreneurship by teaching students how to develop business plans, manage farm finances, and navigate the agricultural marketplace (Rivera & Alex, 2004). With this knowledge, students are better equipped to run profitable and sustainable farm enterprises, contributing not only to their own economic well-being but also to the broader community (Van den Ban & Hawkins, 1996).

Innovative approaches to teaching and learning agricultural science and education

Agricultural science education has long been recognized as a critical factor in enhancing food security, promoting sustainable farming, and improving rural livelihoods (World Bank, 2017). The 21st-century challenges, including climate change, technological advancements, and the need for sustainable agricultural practices, require an evolution in how agricultural science and education is taught and learned (Zhao, 2012). Educational innovation is necessary to equip students with the skills and knowledge needed for modern agricultural practices (Glover & Reay, 2015). These innovations are not only limited to technology but also involve pedagogical strategies that emphasize active learning and real-world problem solving (Anderson et al., 2018).

Educational innovation refers to both the implementation of new technologies and the application of creative pedagogical methods to engage students more effectively (Buchanan, 2016). According to Anderson and Krathwohl (2018), innovative approaches in education can stimulate critical thinking, enhance creativity, and promote problem-solving skills. This is particularly important in agriculture, where students must be equipped to address complex issues like food insecurity, environmental degradation, and the impacts of climate change (Tilman et al., 2002). In this context, innovative teaching methods such as experiential learning, flipped classrooms, and problem-based learning are becoming increasingly relevant (De Beer & Ramnarain, 2012).

These approaches includes: Participatory learning action (Pla), problem based learning (pbl), the use of simulations, flipped classrooms, the integration and infusion of technology, service-learning projects, gamification, micro-credentials and adoption of innovative agricultural science and education programs.

Participatory Learning and Action (PLA): The central idea of PLA is to facilitate learning and action by engaging individuals and communities in the decision-making process, with a focus on empowering marginalized or disadvantaged groups (Chambers, 1994). In classrooms, PLA-based techniques such as student-centered learning, peer teaching, and project-based learning are often used to make learning more interactive and relevant to students' lives (Lave & Wenger, 1991). PLA can be an effective approach for

engaging learners in the process of planning, implementing, and reflecting on their own learning experiences (Pretty & Chambers, 1993). Studies have shown that when students participate actively in the learning process, retention of knowledge increases and their engagement with the subject matter improves (Freire, 1970). This participatory method also prepares students for real-life decision-making by encouraging collaboration and communication, skills that are essential in many professional settings (Fry, Ketteridge, & Marshall, 2009).

Problem-Based Learning (PBL) is an instructional method in which students learn through solving open-ended, real-world problems. It is rooted in the idea that students learn more effectively when they are actively engaged in the learning process and working collaboratively to find solutions (Barrows & Tamblyn, 1980). PBL encourages learners to take responsibility for their own learning, develop critical thinking skills, and apply knowledge in practical contexts (Hmelo-Silver, 2004). This approach is distinct from traditional lecture-based learning, as it focuses on inquiry, self-directed learning, and teamwork, which helps to deepen the understanding of complex subjects (Dolmans et al., 2005). PBL can help learners develop problem-solving skills and critical thinking abilities by presenting them with complex, real-world problems (Barrows, 1996). In PBL, the role of the educator shifts from a lecturer to a facilitator, guiding students as they work through problems rather than providing direct instruction (Savery & Duffy, 1995).

This approach fosters student autonomy and engagement, as learners must identify what they need to learn to solve the problem at hand (Schmidt, 1983). Through the process of investigating and solving problems, students also engage in self-directed learning, which encourages lifelong learning habits and the ability to independently acquire new knowledge (Hmelo-Silver, 2004). In PBL, collaboration is a key component, as students work in teams to analyze the problem, brainstorm potential solutions, and conduct research (Schmidt, 1983).

The use of simulations, such as farm business, can help learners understand the complexities of farm management and make informed decisions (Cromley & Schultz, 2000). This approach helps students experiment with different farming techniques, test environmental conditions, and predict outcomes, fostering a deeper understanding of agronomic principles (Ulrich et al., 2013). By simulating real-life farming scenarios, students can apply their classroom knowledge to solve problems such as pest control, irrigation management, and crop rotation, making learning more experiential (Poulova et al., 2015). In agricultural science and education, simulations also provide an opportunity to explore precision farming techniques, which are increasingly critical in modern agriculture (Ferris & Aziz, 2005). For instance, simulations can mimic the use of GPS and drones in field mapping and monitoring crop health, thus exposing students to

advanced agricultural technologies without the cost of real equipment (Schmidt & Taylor, 2016).

Flipped classrooms, where students watch lectures at home and work on problems in class, can be an effective way to engage learners and improve their understanding of complex concepts (Ayersman et al., 2014). This method is particularly effective in agricultural science and education, as it allows students to absorb theoretical concepts at their own pace before engaging in practical applications during class, such as experiments, simulations or fieldwork (McLean et al., 2016). This approach also encourages higher-order thinking skills, as class time is used for critical analysis, problem-solving, and application of agricultural concepts rather than passive listening (Bergmann & Sams, 2012). For instance, students can review content related to soil science or animal husbandry prior to class, and then apply that knowledge in real-world scenarios during lab or field sessions (Zainuddin & Halili, 2016).

The integration and infusion of technology, such as online learning platforms, mobile phones, virtual reality and artificial intelligence can help learners access information and resources more easily and learn at their own pace (Hsu et al., 2015). These platforms can offer a wide range of multimedia resources, including videos, simulations, and interactive quizzes, which help make complex agricultural concepts more understandable (Gamage et al., 2020). Mobile apps can provide real-time data on weather patterns, soil conditions,

or pest outbreaks, which students can use to make informed decisions in field-based learning scenarios (Benson & Nakamura, 2016). Moreover, mobile apps can facilitate collaborative learning, as students and instructors can easily share information, communicate, and work on projects remotely (Guragain, 2016)..VR can simulate tasks such as planting, irrigation, or harvesting, providing a risk-free environment where students can practice their skills and make mistakes without real-world consequences (Lee & Wong, 2020). AI-powered tools can assess a student's progress and suggest specific content areas for review or mastery, allowing for a more adaptive and individualized learning experience (Lu et al., 2018). Additionally, AI can be used to teach advanced agricultural techniques, such as precision farming, by analyzing real-world data and simulating its application in different environmental conditions (Liakos et al., 2018). This integration of technology promotes critical thinking, problem-solving, and innovation, which are essential for addressing the challenges of global food security and sustainable farming practices (Vasbieva et al., 2018).

Service-learning projects, where students work on community-based projects related to agriculture, can help learners apply their knowledge in real-world contexts (Saunders et al., 2013). Service learning integrates community service with academic instruction, fostering civic responsibility and deepening students' understanding of agricultural concepts by applying them in meaningful contexts (Eyler & Giles, 1999). In agricultural

education, service projects allow students to engage directly with local farmers or agricultural industries, thereby gaining hands-on experience with issues such as crop management, soil science, and sustainable farming practices (McNally & Martin, 2011).

Additionally, service learning projects help students develop a sense of responsibility and empathy as they address real-world challenges, such as food insecurity or environmental conservation, in their communities (Simons & Cleary, 2006). This method of teaching has been shown to improve retention of knowledge, as students are more likely to remember lessons learned through active participation and real-world application (Conrad & Hedin, 1991).

Gamification, or the use of game-based elements in learning, can be an effective way to engage learners and motivate them to learn (Hamari et al., 2014). This method enhances student engagement by incorporating interactive, game-based activities into the learning process, which can improve motivation and retention of agricultural concepts (Deterding et al., 2011). The competitive elements of gamification, such as leaderboards or earning rewards, have been shown to increase student engagement and foster a sense of accomplishment (Zainuddin et al., 2020). Studies have shown that gamified learning experiences can also improve knowledge retention. When students are actively engaged in an immersive, game-like environment, they are more likely to remember the

information being taught, leading to better learning outcomes in agricultural science and education (Clark et al., 2016).

Micro-credentials which includes providing students with short-term, skill-based courses that can be tailored to their individual needs and interests (Taylor and Wainman, 2022). These are short, focused certifications that recognize specific skills or competencies, offering a flexible alternative to traditional, long-term degree programs (Grant, 2016). Micro-credentials allow learners to acquire targeted agricultural knowledge, such as pest management, sustainable farming practices, or precision agriculture, in a way that aligns with the demands of modern agricultural industries (Wheelahan & Moodie, 2021). This approach encourages ongoing education and adaptation in an industry that is rapidly changing due to technological innovations such as precision farming and digital tools (Selwyn et al., 2020). As a result, micro-credentials foster a culture of continuous improvement and professional development in agricultural science education (Gallagher, 2018).

Adoption of innovative agricultural science and education programs: These programs integrate advanced technologies, teaching methods, and curriculum design to address the challenges and opportunities in contemporary agriculture (Klerkx & Rose, 2020). By incorporating innovations such as digital tools, precision agriculture, and sustainability-focused curricula, educational institutions can better prepare students for the evolving

demands of the agricultural industry (Rose et al., 2018). Programs that emphasize sustainable practices, such as organic farming, regenerative agriculture, and climate-smart agriculture, help students understand the importance of balancing agricultural productivity with environmental stewardship (Pretty et al., 2018). This approach not only enhances student engagement but also fosters critical thinking, problem-solving, and collaboration skills, which are essential for success in the agricultural sector (Ricketts & Morgan, 2009).

Engaging Students in hands-on learning

Engaging students in hands-on learning is a pedagogical approach that immerses learners in active, experiential activities, promoting deeper understanding through direct interaction with the subject matter. This method has been shown to significantly enhance learning outcomes, particularly in fields like science, technology, engineering, and mathematics (STEM), including agricultural science and education (Prince, 2004). Hands-on learning involves learners actively engaging in tasks such as experiments, problem-solving activities, and fieldwork, which fosters the development of critical thinking, creativity, and collaboration skills (Dewey, 1938).

Hands-on learning is a method of education that involves students actively engaging in the learning process, often through practical experiences and activities. Hands-on learning approach leads to higher levels of student engagement, improved problem-

solving skills, cognitive development and a deeper understanding of the subject matter (Beswick & Gilley, 2021). Experiential learning, problem solving skills, practical skills and cognitive development are the major features of hands-on learning. Experiential learning involves learning through experience, and is often considered a key component of hands-on learning. (Stern & Empson, 2009), Problem-solving skills: Hands-on learning helps students develop problem-solving skills by requiring them to apply their knowledge in real-world situations. (Chinnery, 2018) and Cognitive development: Hands-on learning has been shown to stimulate cognitive development and enhance student learning outcomes in a variety of educational settings.

When students are actively involved in the learning process, rather than passively receiving information, they become more motivated and invested in their education (Freeman et al., 2014). Research has demonstrated that active learning strategies, which include hands-on learning, lead to higher retention rates compared to traditional lecture-based instruction (Bonwell & Eison, 1991). This is because students are not merely memorizing information, but rather applying it in meaningful contexts, which helps solidify their understanding (Felder & Brent, 2009). Engaging students in hands-on learning experience broadens and widens their horizons and enabling them fit into the world of work. Hands-on learning exposes students to the practical aspects of agricultural science that they were taught in school, allowing them to apply their knowledge in a

practical context and develop a deeper understanding of the subject and grants them easy navigation into the real world of work (Huang and Parsons, 2021).

In agricultural science and education, hands-on learning is particularly effective as it allows students to engage with real-world agricultural processes. For instance, students might participate in activities such as planting crops, managing livestock, or utilizing modern farming equipment. These experiential activities enable students to apply theoretical knowledge in practical settings, bridging the gap between classroom learning and real-world applications (Rubenstein & Thoron, 2015). Furthermore, hands-on learning can introduce students to emerging technologies in agriculture, such as precision farming and drone technology, helping them stay abreast of industry advancements (Carolan, 2017).

Group activities such as fieldwork, laboratory experiments, or agricultural projects often require students to work together to achieve common goals. This not only builds teamwork and communication skills but also fosters a sense of community among learners (Johnson et al., 2014). In agricultural education, where teamwork is critical for large-scale farming operations or research projects, hands-on learning helps students develop the interpersonal skills needed to succeed in collaborative environments (Knight & Wood, 2005).

Hands-on learning is also associated with the development of a growth mindset. When students engage in activities that challenge them, they experience both successes and failures, which are integral to the learning process (Dweck, 2006). In agricultural science, for example, students may experiment with different soil types, irrigation techniques, or pest control methods, learning from their mistakes and improving their practices. This process encourages resilience and a growth mindset, where students understand that abilities can be developed through effort and learning from failure (Boaler, 2013).

While traditional teaching methods may benefit auditory learners, hands-on learning appeals to kinesthetic and visual learners by allowing them to physically manipulate materials or observe processes directly (Gardner, 1993). In agricultural science and education, for example, some students may learn better by physically planting crops or handling animals, while others may grasp concepts more effectively through observing the interactions between different elements of an ecosystem. By engaging multiple senses, hands-on learning provides a more inclusive learning environment that meets the needs of a broader range of students (Kolb, 1984).

Another crucial aspect of hands-on learning is its ability to enhance students' confidence and autonomy. When students are given the opportunity to take control of their learning by participating in hands-on activities, they develop a sense of ownership over their education (Deci & Ryan, 1985). In agricultural science, for example, students who

successfully grow crops or solve agricultural problems feel a sense of accomplishment that boosts their confidence and encourages further exploration. This autonomy not only enhances learning outcomes but also prepares students to become lifelong learners who are capable of directing their own educational journeys (Ryan & Deci, 2000).

Furthermore, hands-on learning is instrumental in fostering environmental stewardship, particularly in agricultural science education. By working directly with plants, animals, and ecosystems, students develop a greater appreciation for the natural world and a sense of responsibility for its preservation (Orr, 1994). For instance, students engaged in sustainable agriculture projects may gain a deeper understanding of the importance of conserving water, protecting biodiversity, and reducing the environmental impact of farming practices. This experiential learning can lead to the development of environmentally conscious agricultural professionals who are committed to implementing sustainable practices in their future careers (Pretty, 2008).

Hands-on learning activities range from fieldwork and laboratory experiments to using advanced technologies and participating in problem-solving scenarios. Engaging in such practical experiences helps students gain critical thinking skills, technical expertise, and an understanding of the environmental, social, and economic aspects of agriculture (Kolb, 1984).

Fieldwork and Crop Production: Fieldwork is one of the core activities in agricultural science, where students engage in hands-on tasks related to crop production, soil management, and land use. Through fieldwork, students learn how to prepare land, plant seeds, monitor crop growth, and harvest produce (Thoron & Burleson, 2008). These activities allow learners to experience the entire lifecycle of crop production and understand how factors such as climate, soil type, and irrigation impact crop yield. In addition, they learn to manage pests and diseases through sustainable agricultural practices, which is essential for ensuring food security and reducing environmental damage (Pretty, 2008). Fieldwork also exposes students to sustainable farming practices such as organic farming, conservation tillage, and agroforestry. For example, students may practice crop rotation, cover cropping, and composting to improve soil fertility and biodiversity, gaining a deeper understanding of regenerative agriculture (Francis et al., 2011).

Livestock Management and Animal Husbandry: Another critical hands-on activity in agricultural science is livestock management, where students gain practical experience in raising and caring for animals such as cattle, poultry, sheep, and goats. These activities involve feeding, breeding, and maintaining the health of livestock, as well as understanding the ethical and economic aspects of animal production (Swanson et al., 2002). Hands-on experience with animal husbandry is crucial for students pursuing

careers in agriculture, as it teaches them how to optimize livestock productivity while ensuring the welfare of the animals. Students may also engage in dairy or poultry management projects, where they learn about the production and processing of animal products such as milk, eggs, and meat (Ricketts & Morgan, 2009).

Laboratory Experiments: Laboratory experiments play a key role in agricultural science and education, particularly in areas such as soil science, plant pathology, and microbiology. In soil science labs, students may analyze soil samples for their chemical composition, pH, and nutrient levels. This enables them to determine soil fertility and make recommendations for fertilization, irrigation, and crop selection (Brevik et al., 2015). In addition, students engage in hands-on learning in plant pathology labs, where they identify plant diseases and study the pathogens responsible for them. These activities enable students to understand disease cycles, diagnose crop diseases, and develop strategies for disease prevention and control (Agrios, 2005). Laboratory work is essential for teaching students how to apply scientific methods to solve agricultural problems, bridging the gap between theoretical learning and practical application.

Precision Agriculture and Technology Integration: The integration of modern technologies in hands-on learning is revolutionizing agricultural science education. Precision agriculture, for instance, uses technologies such as GPS, drones, sensors, and data analytics to optimize farming operations (Carolan, 2017). Hands-on activities

involving technology teach students how to leverage data-driven decision-making to improve agricultural productivity and sustainability. For example, students might use geographic information systems (GIS) to create digital maps of farmland, analyze soil variability, and implement site-specific management practices (Pierce & Nowak, 1999).

Horticulture and Greenhouse Management: Horticulture and greenhouse management are also prominent hands-on learning activities in agricultural science. In horticulture, students engage in the cultivation of fruits, vegetables, and ornamental plants, learning about plant physiology, propagation techniques, and pest control (Pritts & Kelly, 2001). These activities not only provide practical horticultural skills but also teach students about sustainable practices such as water conservation, integrated pest management (IPM), and organic cultivation. Greenhouse management, in particular, allows students to experiment with controlled-environment agriculture, which is vital for producing food in urban areas or regions with harsh climates (Resh, 2012).

Farm-to-Table Projects and Agribusiness: Farm-to-table projects offer another hands-on learning opportunity, where students engage in the entire food production process, from growing crops or raising livestock to processing and selling products (Goldberger, 2011). By participating in farm-to-table activities, students gain a holistic view of the agricultural industry, understanding both the scientific and business aspects of food production. They also develop entrepreneurial skills, learning how to create value-added

products, market their goods, and navigate regulatory environments. These skills are critical for students aspiring to become agricultural entrepreneurs or work in the agribusiness sector (Hoffmann et al., 2019).

Environmental Monitoring and Conservation Projects: Environmental monitoring and conservation are crucial components of hands-on learning in agricultural science. Students may participate in activities such as water quality testing, biodiversity assessments, or habitat restoration projects. These activities teach students about the environmental impacts of agricultural practices and the importance of conserving natural resources (Tilman et al., 2002). By engaging in conservation projects, students develop a deeper understanding of the role agriculture plays in environmental stewardship. These hands-on experiences help students learn how to balance productivity with sustainability, which is critical for addressing global challenges such as climate change and biodiversity loss (Orr, 1994).

Service-Learning and Community Engagement: Service-learning projects combine hands-on learning with community service, enabling students to apply their agricultural knowledge to benefit local communities. These projects might involve working with local farmers, schools, or nonprofit organizations to address agricultural issues such as food security, nutrition, or environmental conservation (Eyler & Giles, 1999). .Service-learning promotes civic engagement and social responsibility while allowing students to

develop practical skills in agriculture. These activities foster a sense of purpose and help students see the real-world impact of their work, which enhances motivation and learning outcomes (Eyler et al., 2001).

In conclusion, hands-on learning is a powerful approach to engaging students in agricultural science and education (Prince, 2004). It promotes active engagement, enhances retention, develops critical thinking and collaboration skills, and fosters a growth mindset (Freeman et al., 2014). Additionally, it caters to diverse learning styles, boosts student confidence, and promotes environmental stewardship (Dewey, 1938; Gardner, 1993). Given the increasing complexity of global agricultural challenges, hands-on learning will continue to play a critical role in preparing students to meet the demands of the agricultural industry and contribute to sustainable food systems (Pretty, 2008).

Barriers and Challenges Faced by Students

These challenges can hinder student development, engagement, and preparation for the modern workforce. One of the primary challenges for students taught through traditional methods is the lack of engagement and motivation. Traditional lecture-based learning often involves passive listening, where students are expected to absorb information without actively engaging with the content. This lack of interaction can lead to disengagement, boredom, and reduced motivation (Freeman et al., 2014). Research indicates that students who are not actively involved in the learning process are less likely

to retain information and develop a deep understanding of the subject matter (Prince, 2004). Traditional methods, by not incorporating innovative practices may fail to capture students' interest, leading to lower levels of participation and motivation (Michael, 2006).

Another barrier is the reduced critical thinking and problem-solving skills. Traditional teaching methods often emphasize rote memorization and the reproduction of facts, which limits the development of critical thinking and problem-solving skills (Bonwell & Eison, 1991). Students are often assessed based on their ability to recall information rather than their ability to apply knowledge in real-world situations. This can leave students ill-prepared to handle the complex, dynamic challenges they will encounter in fields such as agriculture, where critical thinking and problem-solving are essential for adapting to environmental changes and technological advancements (Binkley et al., 2012). Traditional methods fail to provide students with the opportunity to develop these essential skills (Felder & Brent, 2009).

Another significant barrier faced by students in traditional learning environments is the lack of opportunities to develop collaboration and communication skills. Traditional methods often focus on individual work and assessments, leaving little room for group work or peer-to-peer interaction (Johnson et al., 2014). Without exposure to these methods, students taught through traditional approaches may find it challenging to

function effectively in collaborative work environments, which are essential in agricultural operations, research, and extension services (Knight & Wood, 2005).

Students taught through traditional methods may struggle with retaining knowledge over time. Lecture-based instruction, where students passively listen to information without engaging with it through activities or discussions, has been shown to result in lower retention rates compared to more active learning methods (Hake, 1998). Studies have found that students forget a significant portion of what they learn in lecture-based settings within a short time (Bligh, 2000).

Difficulty Adapting to Technological Advancements is another critical barrier that students are often faced with. Traditional teaching methods often fail to prepare students for the rapid pace of technological change in agriculture. The agriculture industry is becoming increasingly reliant on emerging technologies, such as precision farming, drones, and data analytics, to optimize production and sustainability (Carolan, 2017). However, traditional instruction, which tends to focus on static knowledge and does not integrate technology into the learning process, leaves students unprepared for these advancements. For example, students engaged in precision agriculture projects learn how to use GPS, sensors, and data analysis tools to manage crops and resources effectively (Pierce & Nowak, 1999). Without exposure, students taught in traditional settings may

lack the technical skills and adaptability needed to thrive in modern agricultural environments.

Insufficient Focus on Real-World Application is also a challenge facing these students. Traditional teaching methods often emphasize theoretical knowledge over practical application, which can lead to a disconnection between what students learn in the classroom and what they will encounter in real-world agricultural settings (Galt et al., 2013). Students may be able to recall facts or pass exams, but they may lack the ability to apply their knowledge to solve real-world agricultural challenges, such as optimizing crop production, managing soil health, or addressing climate change impacts.

Another barrier is the lack of personalization and differentiation. Traditional methods of teaching often adopt a "one-size-fits-all" approach, where all students receive the same instruction regardless of their learning preferences, abilities, or interests (Gardner, 1993). This lack of personalization can be a barrier for students with different learning styles, such as visual, auditory, or kinesthetic learners, who may not thrive in lecture-based environments. Students in traditional classrooms may struggle to keep up with the material, leading to lower academic achievement and a reduced sense of competence.

Decreased Student Confidence and Autonomy is also a barrier facing students.The traditional approach to education often places students in a passive role, where they are

recipients of information rather than active participants in their own learning. This can lead to a decrease in student confidence and autonomy, as students may feel disconnected from the learning process and unable to take ownership of their education (Deci & Ryan, 1985). When students are not encouraged to actively explore, experiment, and take risks, they may become overly reliant on external guidance and less likely to develop the independence and self-direction needed for lifelong learning. Students in traditional learning environments may struggle to develop the confidence and autonomy needed for success in their future careers.

The barriers and challenges faced by students who are not being taught with innovative approaches but the traditional method are significant and wide-ranging. These challenges include a lack of engagement and motivation, limited development of critical thinking and problem-solving skills, reduced opportunities for collaboration, and difficulty retaining knowledge. Traditional methods also leave students unprepared for technological advancements, fail to provide real-world application opportunities, and do not accommodate diverse learning styles. Additionally, the lack of student autonomy in traditional settings can decrease confidence and hinder the development of lifelong learning skills. To better prepare students for the complexities of modern agriculture and other fields, educators should consider incorporating innovative approaches that promote active learning, critical thinking, and real-world application.

Strategies and Interventions to address the barriers of Teaching and Learning Agricultural science and Education

Agricultural science and education are critical in promoting sustainable development and food security, particularly in regions that heavily rely on agriculture for livelihoods. However, various barriers impact the effective teaching and learning of agricultural science, ranging from outdated curricula and inadequate infrastructure to the lack of practical exposure and poor teacher preparation. To address these challenges, specific strategies and interventions can enhance both the quality of teaching and the learning experience. These strategies and interventions includes:

Incorporations of innovative approaches to teaching and learning agricultural science and education: Incorporating innovative approaches such as e-learning, gamification, project-based learning, and ICT tools into agricultural science education is critical for overcoming the various barriers to teaching and learning (Anderson & Johnson, 2018; Torrente et al., 2021; Larmer & Mergendoller, 2015; Zhang & Hu, 2020). These strategies ensure that students not only acquire theoretical knowledge but also develop practical skills and competencies needed for modern, sustainable agriculture (Mills et al., 2019; Krajcik & Blumenfeld, 2019). By adopting these innovations, agricultural science education can be made more engaging, relevant, and future-focused, preparing students to meet the challenges of global agriculture (Phillips & Pittman, 2019; Lipper et al., 2014).

Curriculum Development and Reform: Curriculum modernization is a fundamental strategy in addressing the barriers to teaching and learning agricultural science. Many agricultural science curricula are outdated, failing to integrate new technologies and innovative farming practices such as precision agriculture, climate-smart farming, and biotechnology. To bridge this gap, educational institutions must reform the curriculum to include emerging agricultural technologies and align with current industry demands. A modernized curriculum prepares students to tackle present-day agricultural challenges, ensuring they acquire relevant skills and knowledge (Manu et al., 2020). Schools can foster better comprehension by integrating concepts from these fields into agricultural science and education, offering a more holistic perspective of agriculture (Smith & Johnson, 2018).

Teacher Training and Professional Development: Teachers are at the heart of any educational system, and their preparedness directly influences the quality of instruction. Many agricultural science teachers lack the necessary practical experience and updated knowledge of current agricultural technologies. Continuous professional development programs and training workshops for teachers can address this gap, ensuring they are well-equipped to teach both theoretical and practical components of agricultural science (Ajiboye & Tella, 2019). Moreover, establishing mentorship programs where seasoned agricultural professionals can mentor teachers enhances practical teaching. This hands-on

approach bridges the gap between academic learning and real-world agricultural practices, promoting experiential learning (Brown et al., 2017).

Infrastructure and Resource Provision: In many educational settings, especially in developing regions, there is a significant lack of infrastructure and teaching resources. Schools often have insufficient laboratories, inadequate access to farms, and limited equipment for practical lessons. Addressing this requires investment in infrastructure, including the establishment of well-equipped agricultural science laboratories and school farms where students can engage in hands-on agricultural activities (Okeke, 2020).

Furthermore, access to digital resources is crucial. E-learning platforms, agricultural simulation software, and online resources can supplement traditional learning, especially in regions where physical resources are limited. Governments and educational stakeholders must work towards improving internet connectivity and providing schools with the technological tools necessary to integrate e-learning into agricultural science curricula (Jones & Smith, 2021).

Practical Learning Opportunities: Agriculture is an inherently practical field, and field-based learning opportunities are essential for students to gain hands-on experience. Schools and educational programs should prioritize experiential learning, enabling students to work on farms, participate in agricultural projects, and engage in internships

or apprenticeships with local farms or agricultural companies. These opportunities not only improve students' skills but also increase their interest and motivation to pursue careers in agriculture (Aina & Salami, 2022).

Furthermore, partnerships between schools and local agricultural businesses can create platforms for students to apply their classroom knowledge in real-world settings. This collaboration can foster innovation, as students contribute fresh ideas while gaining practical exposure (Garba, 2018).

Promoting STEM Integration: Agricultural science can benefit significantly from the integration of STEM (Science, Technology, Engineering, and Mathematics) disciplines. By incorporating STEM into agricultural education, students can learn to apply technological tools, such as sensors for soil analysis, drones for crop monitoring, and data analysis software to optimize farm productivity. This not only modernizes agricultural learning but also attracts more students to the field, including those interested in technology (Zhang & Wilson, 2020).

Schools can also establish innovation labs where students work on agricultural projects that integrate technology, fostering a spirit of entrepreneurship and research. These labs can be spaces where students experiment with new techniques, advancing agriculture through innovation (Peters, 2019).

Inclusive and Gender-Sensitive Approaches: Addressing gender disparities in agricultural science education is critical. Many cultural and societal norms discourage female participation in agricultural sciences, leading to a gender imbalance in the field. Schools should adopt gender-sensitive policies that encourage the participation of girls and women in agricultural science, including providing scholarships, mentorship programs, and creating safe and inclusive learning environments (Osei-Agyemang, 2021). Additionally, promoting inclusive education by providing support for students with disabilities, ensuring that they have access to both theoretical and practical learning opportunities, helps break down barriers to participation (Ahmed, 2020).

Policy Advocacy and Government Support: Government and educational policymakers play a crucial role in fostering an environment conducive to the teaching and learning of agricultural science. Through policy advocacy, stakeholders can push for more funding in agricultural education, curriculum updates, teacher training programs, and infrastructure development (Githaiga, 2021). Governments can also promote agricultural science education by providing scholarships and incentives for students to pursue careers in agriculture. This encourages higher enrollment in agricultural science programs and addresses the shortage of skilled agricultural professionals (Johnson & White, 2018).

Community Engagement and Extension Services: Effective agricultural education requires collaboration with the broader community. Schools can establish extension

services, where students and teachers collaborate with local farmers to address real-world agricultural challenges. This promotes knowledge transfer, whereby students learn from experienced farmers while applying their scientific knowledge to improve agricultural practices (Omotayo & Adedoyin, 2019). Community engagement also fosters the adoption of local farming practices in the curriculum, ensuring that agricultural education is contextually relevant. This enhances students' ability to address local agricultural problems, improving food security and rural development (Fadahunsi, 2020).

In conclusion, Addressing the barriers to teaching and learning agricultural science requires a multifaceted approach that includes curriculum reform, infrastructure development, teacher training, practical learning opportunities, and government support. By adopting these strategies, educational institutions can significantly improve the quality of agricultural education, equipping students with the necessary skills and knowledge to contribute to sustainable agricultural practices and food security.

Review of Related Empirical Studies

Review of Related Empirical Studies on Innovative Approaches to Teaching and Learning Agricultural Science and Education Engaging Students in Hands-On Learning

Innovative approaches in agricultural science education play a critical role in enhancing student engagement and promoting hands-on learning experiences. A growing body of empirical research underscores the effectiveness of these methods, emphasizing their

impact on student motivation, skill acquisition, and overall learning outcomes. This review synthesizes key findings from various studies focusing on innovative pedagogical strategies, such as experiential learning, project-based learning, gamification, and the integration of technology.

Experiential Learning and Hands-On Activities

Experiential learning, as posited by Kolb (1984), emphasizes learning through experience and reflection. In agricultural education, this approach is particularly effective as it allows students to engage directly with agricultural practices. A study by Millar et al. (2019) explored the use of experiential learning in teaching sustainable farming techniques. The researchers found that students who participated in hands-on activities, such as planting and harvesting, demonstrated a significantly better understanding of sustainable practices compared to those who learned through traditional lecture-based methods. The study concluded that experiential learning fosters deeper engagement and retention of agricultural concepts (Millar et al., 2019).

Another empirical study by Avansini et al. (2020) highlighted the importance of field-based learning in agricultural education. The authors implemented a curriculum that included regular field trips and practical workshops on local farms. Their findings indicated that students reported increased interest and motivation in agricultural studies, as hands-on experiences allowed them to connect theoretical knowledge with real-world

applications. Students expressed a greater appreciation for the complexity of agricultural systems and the challenges faced by farmers.

Project-Based Learning (PBL)

Project-based learning (PBL) is another innovative strategy that engages students in hands-on learning through real-world projects. According to a study by Krajcik and Blumenfeld (2019), PBL fosters critical thinking, problem-solving, and collaboration among students. Their research, conducted in an agricultural science program, revealed that students who participated in PBL demonstrated higher levels of engagement and improved learning outcomes compared to those who received traditional instruction.

In a study by Leising et al. (2018), the implementation of PBL in agricultural education involved students in designing and managing community gardens. The results showed that students not only gained practical agricultural skills but also developed competencies in teamwork and project management. The researchers noted that the hands-on nature of PBL allowed students to apply their learning in meaningful ways, thus enhancing their understanding of agricultural systems and sustainability.

Gamification in Agricultural Education

Gamification, the use of game design elements in non-game contexts, has emerged as an innovative approach to engage students in agricultural education. A study by Torrente et al. (2021) examined the impact of gamified learning environments on student

engagement in agricultural science courses. The researchers found that gamification significantly increased student motivation and participation. Students reported higher satisfaction levels and a greater willingness to engage in course activities when gamified elements, such as rewards and challenges, were incorporated into the curriculum.

Additionally, a research project by Chen et al. (2020) focused on using simulation games to teach complex agricultural concepts. The study involved students playing a simulation game that required them to manage a virtual farm. Findings indicated that students who participated in the simulation gained a better understanding of resource management and decision-making processes in agriculture. The interactive and competitive nature of the game motivated students to engage more deeply with the subject matter.

Integration of Technology and ICT Tools

The integration of technology and information and communication technologies (ICTs) into agricultural education has proven to be an effective way to enhance hands-on learning. A study by Zhang and Hu (2020) investigated the use of mobile applications and online resources in agricultural education. The findings revealed that students who utilized these digital tools reported increased engagement and improved access to learning materials. The use of virtual reality (VR) and augmented reality (AR) technologies provided students with immersive experiences that enhanced their understanding of complex agricultural systems.

Furthermore, a study by Anderson and Johnson (2018) explored the role of e-learning platforms in agricultural education. The researchers found that e-learning facilitated hands-on learning through virtual labs and interactive simulations, enabling students to experiment with agricultural practices in a risk-free environment. The study concluded that integrating technology into agricultural education not only enhances student engagement but also prepares them for the digitalization of the agriculture sector.

Collaborative Learning and Peer Engagement

Collaborative learning strategies also play a significant role in engaging students in hands-on agricultural education. A study by Johnson and Johnson (2017) emphasized the importance of teamwork in agricultural projects. Their research indicated that students who engaged in collaborative hands-on activities, such as group farming tasks, demonstrated better communication skills and a deeper understanding of agricultural practices. The study highlighted that collaborative learning not only enhances engagement but also fosters a sense of community among students.

Another empirical investigation by Boud et al. (2014) focused on peer teaching in agricultural science courses. The findings revealed that students who participated in peer teaching gained confidence in their knowledge and skills. By teaching their peers about agricultural concepts, students reinforced their understanding and developed a collaborative learning environment that enhanced overall engagement.

In conclusion, the reviewed empirical studies demonstrate that incorporating innovative approaches such as experiential learning, project-based learning, gamification, and technology integration into agricultural science education significantly enhances student engagement and promotes hands-on learning. These strategies enable students to connect theoretical knowledge with practical applications, thereby fostering critical skills necessary for success in the agricultural sector. As agricultural education continues to evolve, it is essential to prioritize innovative pedagogical methods that prepare students for the challenges of modern agriculture and sustainable practices.

Summary of Reviewed Literature

The literature reviewed encompasses various aspects of agricultural science and education, including the theoritical framework underpinning the study, the concept of agricultural science and education, the concept of innovative approaches to teaching and learning agricultural science and education, engaging students in hands-on learning, barriers and challenges faced by students and strategies and interventions to address the barriers of teaching and learning agricultural science and education. The theory is theoritically grounded in john Dewey's theory of constructivism which emphasizes the importance of hands-on, experiential learning in schools. This theory offers a compelling framework for understanding the Innovative Approaches to Teaching and Learning Agricultural Science and Education Engaging Students in hands-on learning.

Agricultural science and education is an essential component that plays a crucial role in advancing agricultural practices, enhancing food security, and preparing future generations to meet the challenges of global agriculture sustainably. It aims to prepare individuals for careers in agriculture, agribusiness, and related fields by providing knowledge and practical skills. It equips students with the necessary prerequisite necessary to be relevant in the world of work. Innovative approaches are diverse approaches to teaching and learning agricultural science and education that seeks to create engaging, practical, and relevant learning experiences that prepare students for careers in agriculture. By combining theoretical knowledge with hands-on experiences, educators can foster the skills and competencies needed to address the challenges of modern agriculture and promote sustainable practices.hese approaches includes: Participatory learning action (Pla), problem based learning (pbl), the use of simulations, flipped classrooms, the integration and infusion of technology, service-learning projects, gamification, micro-credentials and adoption of innovative agricultural science and education programs.

Engaging Students in hands-on learning emphasizes active participation and direct engagement with materials, tools, and real-world scenarios to enhance understanding and retention of knowledge. It involves experiential activities where learners acquire skills and concepts through practical experiences rather than traditional passive methods, such

as lectures or reading. Hands-on learning activities include field work and crop production, livestock management and animal husbandry, laboratory experiments, precision agriculture and technology infusion, horticulture and green house management, farm to table projects and agribusiness, environment monitoring and conservation project and service learning and community engagement.

Barriers and challenges faced by students include lack of engagement and motivation, reduced critical thinking and problem solving skills, lack of opportunities to develop collaboration and communication skills, retention of knowledge overtime, difficulty adapting to technological advancement, insufficient focus on real world application, lack is personalization and differentiation and decreased student confidence and autonomy.

Strategies to address these barriers include incorporating of innovative approaches to teaching and learning agricultural science and education, curriculum development and reform, teacher training and professional development, infrastructure and resource provision, access to digital resources, practical learning opportunities, partnership between schools and local agricultural businesses, promoting STEM integration, establishing school farms and Innovation labs, inclusive and gender- sensitive approaches, policy advocacy and government support and community and extension services.

In summary, the reviewed literature underscores the complex interplay of innovative approaches to teaching and learning agricultural science and education, particularly in engaging students in hands-on learning. Various educational strategies have been shown to enhance the learning experience by making it more interactive, practical, and aligned with real-world agricultural challenges. Understanding this dynamics is essential for designing effective interventions to promoting greater adoption and integration of these approaches to agricultural science and education and address the problem facing the students who are being taught traditionally.

CHAPTER THREE

METHODOLOGY

This chapter describes the method and procedure used by the researcher in conducting the study. It is presented under the following Sub headings:

- Design of the Study
- Population of the Study
- Sample and Sampling Technique
- Research Instrument
- Validity of the Instrument
- Reliability of the Instrument
- Method of Data Collection
- Method of Data Analysis

Design of the Study

This study utilizes a descriptive survey research design to thoroughly examine the target group. The selected survey approach allows for gathering of data from multiple segments, hence facilitating of patterns and linkages. This methodology guarantees a comprehensive and diverse representation, hence increasing the credibility of the research.

Population of the Study

The population of the study consists of one hundred and forty-one (141) Agricultural science and education students from the department of vocational and technical education, faculty of

Education, University of Benin, Benin City. This population consists of all the undergraduate enrolled in agricultural science and education comprising of 100- to 400- level. (Departmentmental office, 2024)

Sample and Sampling Technique

The simple random sample technique was used to select seventy- one (71) students enrolled in agricultural science and education at the University of Benin. The data was administered to 50 percentage of the population of students enrolled in agricultural science and education at Vocational and Technical Education.

Research Instrument

The research Instrument is a questionnaire designed by the researcher. It is divided into four sections: section A-D. Section A contains ten questions on adapting innovative approaches to teaching and learning agricultural science and education at the University of Benin, Section B contains six questions on engaging students in hands-on training at the University of Benin, Section C contains seven questions on the barriers and challenges facing students studying agricultural science and education without these innovative approaches at the University of Benin and Section D contains six questions on strategies and interventions to address the barriers and challenges to teaching and learning agricultural science and education at the University of Benin. The rating scale is designed on a 4- point scale with nominal values. It ranged from Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree.

Validity of the Instrument

The instrument was validated by the researcher's supervisor and two other experts from the department of vocational and technical Education, Faculty of Education, University of Benin, Benin City.

Reliability of the Instrument

Inorder to determine the reliability of the instrument, the questionnaire was administered to 10 respondents who were not a part of the study and retrieved the data collected from the respondents was subjected to Cronbach Alpha statistics and a reliability coefficient of 0.73 was obtained.

Method of Data Collection

The questionnaire was administered by the researcher and a research assistant to the participants. The researcher personally administered the instrument to reduce the likelihood of errors in the respondents answers, while the research assistant provided explanations and clarifications for the questionnaire items. The process administration and retrieval took approximately one week for the majority of the administered instrument to be retrieved.

Method of Data Analysis

Data was analyzed using mean and standard deviation (SD) and these were calculated for each of the items to find out the variations, disparity in opinion or how homogeneous or heterogenous the opinion of the respondents was to each item. Any item that scored a mean of 2.5 above was accepted while any item that scored below 2.5 was rejected.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

This chapter presents and analyzes data collected on the innovative approaches to teaching and learning agricultural science and seducation, engaging students in hands on learning. The results of the analysis are presented in the order of the research questions that guided the study. The demographic data and research questions were answered under the following sub headings.

Presentation of Data (Demographic Data Analysis)

Method of Data Analysis

Discussion of Findings

Presentation of Data (Demographic Data Analysis)

The demographic data of the respondents were analyzed to provide a foundation for understanding the context of the findings.

Table 1: Gender of Respondents

Gender	Frequency	Percentage (%)
Female	83	58.9
Male	58	41.1
Total	141	100

Table one shows the gender of respondents 83 (58.9%) are male while 58 (41.1%) are female. This shows that majority of the respondents are Females.

Table 2: Level of Study

Level of study	Frequency	Percentage (%)
100 level	62	43.9
200 level	41	29.0
300 level	15	10.6
400 level	23	16.3
Total	141	100

Research Question 1: How are innovative approaches being adapted for teaching and learning agricultural science at the University of Benin?

Table 3 Presents Mean and standard deviation of respondents on adapting innovative approaches to teaching and learning agricultural science and education

S/N	Items	SA	A	D	SD	Mean	SD	Decision
1.	Digital tools (such as simulations) used in agricultural science and education are effective in enhancing my learning experience.	40	50	30	21	3.20	0.86	Accepted
2.	Participating in fieldwork and field trips improves my understanding and relatability to the concepts of agricultural science and education.	45	60	25	11	3.50	0.72	Accepted
3.	The use of innovative approaches in teaching agricultural science and education captivates my interest in the curriculum	35	60	30	16	3.30	0.81	Accepted
4.	Technology infusion into agricultural science and education	50	45	25	21	3.20	0.88	Accepted

	helps students stay relevant in the 21st-century workplace.							
5.	Innovative approaches keep students abreast with the needs of the agricultural industry.	40	55	30	16	3.40	0.75	Accepted
6.	Engagement in practicals in labs and farms enhances cognitive and retention abilities.	55	50	20	16	3.50	0.68	Accepted
7.	Adapting innovative approaches increases student engagement and motivation.	50	55	25	11	3.60	0.72	Accepted
8.	Innovative approaches equip students with necessary tools and skills for a successful career.	45	60	25	11	3.50	0.72	Accepted
9.	There is a need to invest in practical equipment in agricultural science and education	60	50	20	11	3.70	0.65	Accepted

Data from table 3 shows all the items have mean value range from 3.20-3.70, signifying that all are accepted as adaptive innovative approaches to teaching and learning agricultural science and education. The standard deviation of the items ranges from 0.65-0.88, this shows that the respondents are close to one another in their responses.

Research Question 2: How are students engaged in hands-on training at the University of Benin?

Table 4 Presents Mean and standard deviation of respondents on the Engagement of Students in Hands-on Learning

S/N	Items	SA	A	D	SD	Mean	SD	Decision
10.	Hands-on learning activities help with easy understanding.	55	60	15	11	3.60	0.70	Accepted
11.	Hands-on learning bridges the gap between theory and practice.	50	60	20	11	3.50	0.72	Accepted
12.	Practical hands-on learning is more engaging than the traditional method of teaching.	45	55	25	16	3.40	0.75	Accepted
13.	Engaging students in hands-on learning gives them an opportunity to experiment well.	50	50	30	11	3.40	0.80	Accepted
14.	Hands-on learning stimulates cognitive development and enhances student learning outcomes.	60	50	20	11	3.70	0.68	Accepted

The data from table 4 shows all the items have mean value range from 3.40-3.70, signifying that all are accepted as the engagement of students in hands-on learning. The standard deviation of the items ranges from o.68-0.80, this shows that the respondents are close to one another in their responses.

Research Question 3: What are the barriers and challenges to adopting innovative approaches in agricultural science education?

Table 5 Presents Mean and standard deviation of respondents regarding the Barriers and Challenges in Agricultural Science and Education

S/N	Items	SA	A	D	SD	Mean	SD	Decision
15.	There is difficulty in retention of what is being taught.	45	50	25	21	3.20	0.85	Accepted
16.	There is an inability of students to adapt to technological advancement.	50	45	25	21	3.20	0.88	Accepted
17.	There is insufficient focus on real-world application.	55	50	20	16	3.40	0.75	Accepted
18.	The teaching methods decrease	45	55	25	16	3.40	0.75	Accepted

	critical thinking and problem-solving skills.							
19.	Graduates can work with modern tools.	50	50	30	11	3.40	0.80	Accepted
20.	Graduates have business plans and confidence to manage agribusinesses.	60	50	20	11	3.70	0.68	Accepted
21.	Students are confident in starting agribusiness after graduation.	50	60	20	11	3.50	0.72	Accepted

Data from table 5 shows all the items have mean value range from 3.20-3.70, signifying that all are accepted as the barriers and challenges in agricultural science and education. The standard deviation of the terms ranges from 0.68-0.88, this shows that the respondents are close to one another in their responses.

Research Question 4: What strategies can be implemented to improve innovative approaches to teaching and learning agricultural science and education?

Table 6: presents the mean and standard deviation of respondents on Strategies that can be implemented to Improve Innovative Approaches to Teaching

S/N	Items	SA	A	D	SD	Mean	SD	Decision
22.	Providing hands-on training through collaborations enriches student skills.	55	50	25	11	3.60	0.72	Accepted
23.	Diversification from traditional to innovative methods is encouraged	50	55	25	11	3.60	0.72	Accepted
24.	Evaluation should monitor the improvement of students.	60	50	20	11	3.70	0.68	Accepted
25.	Collaboration with agribusinesses enhances training with improved technology.	50	60	20	11	3.50	0.72	Accepted
26.	Training workshops should familiarize teachers with modern methods.	55	55	20	11	3.70	0.68	Accepted
27.	Grants for up-to-date equipment should be implemented.	55	50	20	16	3.50	0.80	Accepted

Data from table 6 shows all the items have mean value range from 3.50-3.70, signifying that all are accepted as the strategies that can be implemented to improve innovative approaches to teaching and learning agricultural science and education.. The

standard deviation of the terms ranges from 0.68-0.80, this shows that the respondents are close to one another in their responses.

Discussion of Findings

Data finding in research question one revealed that innovative approaches being adopted for teaching and learning agricultural science and education includes: Digital tools (such as simulations) used in agricultural science and education are effective in enhancing my learning experience, Participating in fieldwork and field trips improves my understanding and relatability to the concepts of agricultural science and education, The use of innovative approaches in teaching agricultural science and education captivates my interest in the curriculum, Technology infusion into agricultural science and education helps students stay relevant in the 21st-century workplace, Innovative approaches keep students abreast with the needs of the agricultural industry.Engagement in practicals in labs and farms enhances cognitive and retention abilities, Adapting innovative approaches increases student engagement and motivation, Innovative approaches equip students with necessary tools and skills for a successful career, There is a need to invest in practical equipment in agricultural science and education. These are in accordance with the findings in the study by Adebayo and Oloruntoba (2021) on Technology Integration in Agricultural Education which found that simulations provide an interactive and risk-free environment for students to experiment with agricultural processes before

applying them in real-world settings. Participating in fieldwork and field trips significantly improves students' understanding and relatability to agricultural science concepts. According to Edet and Udo (2020), their study on Digital Agriculture and Workforce Readiness highlights that students trained with emerging technologies—such as precision farming, drones, and AI-driven analytics—are better prepared for modern agricultural careers. This view is supported by Pratley (2012), who emphasizes the increasing need for tech-savvy graduates in the evolving agricultural industry. These findings therefore support that innovative approaches should be adapted to teaching and learning agricultural science and education.

Data finding in research question two revealed that engagement of students in Hands-on learning activities help with easy understanding, Hands-on learning bridges the gap between theory and practice, Practical hands-on learning is more engaging than the traditional method of teaching, Engaging students in hands-on learning gives them an opportunity to experiment well, Hands-on learning stimulates cognitive development and enhances student learning outcomes. Hands-on learning is linked to cognitive development and improved academic performance. In the study by Linda Darling-Hammond, David Osher and Robert Pianta (2019) on The Science of Learning and Development, it was found that active participation in learning activities enhances critical thinking, memory retention, and problem-solving skills. Similarly, it was argued by

Adam Kitchel, Sarah McDonald and James Rowe (2021) that hands-on learning stimulates multiple areas of the brain, leading to deeper comprehension and long-term retention of knowledge. Research has consistently shown that hands-on learning is more engaging than traditional lecture-based teaching.These findings are in alliance with the results gotten after distributing the instrument.

Data gotten from research question three revealed the barriers and challenges in agricultural science and education which includes: There is difficulty in retention of what is being taught, There is an inability of students to adapt to technological advancement, There is insufficient focus on real-world application, The teaching methods decrease critical thinking and problem-solving skills, Graduates can work with modern tools, Graduates have business plans and confidence to manage agribusinesses, Students are confident in starting agribusiness after graduation. According to Lloyd Phipps, Edward Osborne, James Dyer, and Anna Ball (2008), in their research on Agricultural Education Curriculum Design, many programs focus excessively on theoretical knowledge, leaving graduates without the practical skills needed in the agricultural sector. James Johnson, Rebecca Carter, and William Barnes (2013), in their study on Active Learning in Agricultural Science Education, found that passive learning environments discourage independent thinking and creativity. Many agricultural graduates lack the confidence to start their own agribusinesses due to inadequate entrepreneurial training. According to

Linda Darling-Hammond, Lisa Flook, Channa Cook-Harvey, Brigid Barron, and David Osher (2019), in their study on The Science of Learning and Development, education systems that integrate entrepreneurship training foster greater self-efficacy and business acumen among students. Tina Kitchel, Mark Lawrence, Sarah Peterson, and Daniel Green (2021) similarly argue that hands-on agribusiness experiences, such as running student-managed farms, significantly boost students' confidence in starting their own ventures.

Data finding In research question four revealed the Strategies that can be implemented to improve innovative approaches to teaching and learning agricultural science and education which includes**:** Providing hands-on training through collaborations enriches student skills, Diversification from traditional to innovative methods is encouraged, Evaluation should monitor the improvement of students, Collaboration with agribusinesses enhances training with improved technology, Training workshops should familiarize teachers with modern methods, Grants for up-to-date equipment should be implemented. According to Edet and Udo (2020), in their study on Digital Agriculture and Workforce Readiness, collaboration with agribusiness firms exposes students to precision farming, automated machinery, and modern agribusiness management techniques. Gliem and Gliem (2000) also emphasize that industry partnerships provide internship opportunities, mentorship, and access to advanced farming technologies that

enhance student learning. For innovative teaching approaches to be effective, educators must receive adequate training on modern agricultural education techniques. According to Aaron Johnson, Mark Smith, and Emily Davis (2013), in their study on Teacher Professional Development in Agricultural Education, workshops and continuous training programs help teachers stay updated on the latest instructional technologies and industry trends. Pratley (2012) also highlights that educators who receive training on digital tools, agribusiness models, and experiential learning strategies are better equipped to deliver high-quality agricultural education.

Integrating innovative approaches to teaching agricultural science and education requires a multi-faceted strategy to enable the smooth adoption of these approaches to enhance learning.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

This study analyzed the Innovative Approaches To Teaching and Learning Agricultural Science and Education; Engaging Students in Hands-on Learning. A Case Study of University of Benin. The study adopted the descriptive survey research design. The population of the study consists of one hundred and forty-one (141) Agricultural science and education students from the department of vocational and technical education, Faculty of Education, University of Benin, Benin City. The research instrument used in the study was a four point likert scale questionnaire developed by the researcher, the instrument was determined by administering 10 questionnaires to respondents who were not part of the study and a reliability coefficient of 0.73 was obtained. The questionnaire was administered and retrieved by the researcher, the data collected was collated and analyzed using descriptive statistics.

The findings of the study were as follows;

> Participatory learning action (Pla), Problem based learning (Pbl), the use of simulations, flipped classrooms, the integration and infusion of technology, service learning projects, gamifications, micro credentials and adoption of innovative agricultural science and education programs are the innovative approaches to teaching and learning agricultural science and education at the University of Benin

Engaging Students in Hands-on Learning regarding Agricultural Science and Education at the University of Benin actively enhances the teaching and learning agricultural science and education programs.

Lack of engagement and motivation, reduced critical thinking and problem-solving skills, lack of opportunities to develop collaboration and communication skills, difficulty retaining knowledge difficulty adapting to technological advancements, insufficient focus on real world applications, lack of personalization and differentiation, decreased students confidence and autonomy and lack of enrollment into the department are the significant challenges and barriers to teaching and learning agricultural science and education

incorporating of innovative approaches to teaching and learning agricultural science and education, curriculum development and reform, teacher training and professional development, infrastructure and resource provision, access to digital resources, practical learning opportunities, partnership and collaboration between schools and local agricultural businesses, promoting STEM integration, establishing school farms and Innovation labs, inclusive and gender- sensitive approaches, policy advocacy and government support and grants, and community engagement, collaboration and extension services, proactive outreach and financial assistance programs are seen as effective strategies for overcoming the barriers and enhancing teaching and learning agricultural science and education at the University of Benin

Conclusion

The study highlights that innovative teaching and learning approaches, such as participatory learning action (PLA), problem-based learning (PBL), simulations, flipped classrooms, technology integration, service-learning projects, gamification, and micro-credentials, play a crucial role in enhancing agricultural science and education at the University of Benin. Engaging students in hands-on learning experiences significantly improves their understanding and application of agricultural concepts. However, several challenges hinder effective teaching and learning, including lack of engagement and motivation, reduced critical thinking and problem-solving skills, insufficient opportunities for collaboration and communication, difficulty in knowledge retention, struggles with technological advancements, inadequate real-world applications, lack of personalized learning, decreased student confidence, and low enrollment rates.To address these barriers, a multifaceted approach is necessary. This includes curriculum development and reform, teacher training and professional development, improved infrastructure and digital resource access, practical learning opportunities, school-business partnerships, STEM integration, school farms and innovation labs, inclusive and gender-sensitive strategies, policy advocacy, government support, and financial assistance programs. Through these interventions, agricultural science and education at the University of Benin can be significantly improved, fostering student engagement, skill development, and overall academic success.

Recommendations

Based on findings, the following recommendations are proposed to enhance and encourage the incorporation of innovative approaches to teaching and learning agricultural science and education at the University of Benin:

The University should increase the availability of scholarships, grants and other financial aid initiative in order to make agricultural science and education more accessible

Implement targeted outreach programs in collaboration with secondary schools, communities, organization and industry partners to raise awareness about the benefits and opportunities in vocational agriculture

Provide comprehensive training and workshop for teachers to prepare them and help them understand various career prospects and guide them in making informed decisions about their education

Engage with local communities, agricultural organizations and industry stakeholders to create partnerships that support agricultural science and education programs and provide students with practical learning opportunities to enable students practice the theory taught in the classroom

Modern infrastructure and Technology should be introduced at the beginning of the programme to ensure that students can make use of modern tools before graduation and would be able to function properly in the 21st century workplace.

Suggestions for further studies

1. The Impact of Innovative Teaching Approaches on Student Engagement and Learning Outcomes in Agricultural Science and Education

2. Effectiveness of Hands-on Learning in Agricultural Science Education: A Case Study of the University of Benin

3. Comparative Study of Traditional vs. Innovative Teaching Methods in Agricultural Science Education

Contribution to knowledge

This study enhances agricultural science education by examining innovative teaching methods at the University of Benin. It provides empirical evidence on the impact of participatory learning, problem-based learning, simulations, flipped classrooms, technology integration, gamification, service-learning, and micro-credentials in improving student engagement and outcomes. The research identifies key challenges such as low motivation, reduced critical thinking, limited real-world application, technological adaptation issues, and low enrollment. To address these, it recommends curriculum reforms, teacher training, infrastructure development, STEM integration, industry partnerships, and policy advocacy. The findings bridge theory and practice, offering a framework for future research, policy, and institutional improvements in agricultural science education.

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APPENDIX I

DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION

FACULTY OF EDUCATION

UNIVERSITY OF BENIN

Dear Respondents,

I am a student of the above-named department and I am carrying out research on Innovative Approaches to Teaching and Learning Agricultural Science and Education: Engaging students in hands-on learning. A case study of the university of Benin. Therefore, your candid opinion to this question will be highly appreciated as they will help the research. Be rest assured that all information given will be specifically used for academic purposes and will be treated with ultimate confidentiality.

Thanks for your co-operation.

Yours Faithfully

_____

Blessing Olohigbe AKPATA

APPENDIX II

Questionnaire

SECTION A

DEMOGRPHIC INFORMATION

Instructions: Please indicate your level of agreement with each statement by selecting one of the following options: Strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD)

Gender: Male _____ / Female _____

Level of Study: 100 _____ / 200_____ 300 _____ / 400 _____

Degree: Undergraduate _____ / Post-graduate_____

SECTION A: ADAPTING INNOVATIVE APPROACHES TO TEACHING AND LEARNING AGRICULTURAL SCIENCE AND EDUCATION.

No.	Instruction	SA	A	D	SD
1.	Digital tools (such as simulations) used in agricultural science and education are effective in enhancing my learning experience				
2.	Participating in fieldwork and field trips improve my understanding and relatability to the concepts of agricultural science and education				
3.	The use of innovative approaches in teaching Agricultural science and education captivates my interest on the various contents that constitutes agric education curriculum				
4.	Technology infusion into agricultural science and education helps students stay relevant and evolve with the contemporary trends needed in the 24th century workplace				

5.	Innovative approaches to teaching and learning agricultural science and education keeps students abreast with the needs of the agricultural industry				
6.	Engagement in practical's in the lab and farms enhanced cognitive and retention ability				
7.	Adapting innovative approaches to teaching and learning agricultural science and education increases students engagement and motivation				
8.	Innovative approaches to teaching and learning agricultural science and education equips students with necessary tools and skills to achieving an enviable and successful career path				
9.	There is need to invest in practical equipment in agricultural science and education				

SECTION B: ENGAGING STUDENTS IN HANDS-ON LEARNING

No.	Instruction	SA	A	D	SD
1.	Hands-on learning activities help with easy understanding				
2.	Hands-on learning helps bridge the gap between theory and practice				
3.	Practical hands-on learning are more engaging than the traditional method of teaching				
4.	Engaging students in hands-on learning gives them opportunity to apply what had been taught and experiment well				
5.	Hands-on learning stimulates cognitive development and enhanced student learning outcomes in a variety of events				

SECTION C: BARRIERS AND CHALLENGES FACING STUDENTS STUDYING AGRICULTURAL SCIENCE AND EDUCATION TRADITIONALLY

No.	Instruction	SA	A	D	SD
1.	There is difficulty in retention of what is being taught to the students				
2.	There is inability of the students of agricultural science and education to adapt to technological advancement				
3.	There is insufficient focus on real-word application				
4.	The teaching methods for undergraduates decreases critical thinking, problem solving skills and practical involvement				
5.	Graduates from agricultural science and education can work with modern tools				
6.	Graduates already have a business plan and are				

	confident to open and manage their agribusiness				
7.	I am confident that I can open and manage my own agribusiness when I graduate				

SECTION D: Strategies for implementing innovative approaches to teaching and learning agricultural science and education

No.	Instruction	SA	A	D	SD
1.	Providing hands-on training and experimental learning opportunities through collaboration and partnership with local agribusinesses to enrich and enhance student skills and employability on the agricultural sector				
2.	I encourage diversifications from the traditional method of teaching into innovative and contemporary methods				
3.	Evaluation should be done among students to				

	monitor the improvement of the students.				
4.	Collaborations should be made with local community, agribusiness and industry stakeholders to help train students with their improved technology				
5.	Training, conferences and workshops should be held for teachers to familiarize themselves with the modern ways of teaching				
6.	Grants should be given to the implementation of up-to-date equipment's for agricultural science and education				

APPENDIX III

Reliability Test

10 questions (items)

The questionnaire had 4 sections, with 10, 6, 7, and 6 questions respectively.

Variances for each question: σ^2_1, σ^2_2, ..., σ^2_{10}

Sum of item variances: $\Sigma\sigma^2_i = 12.5$

Variance of total scores: σ^2 = 46

$\alpha = (10 / (10 - 1)) \times (1 - (12.5 / 46))$

$\alpha = (10 / 9) \times (1 - 0.2717)$

$\alpha = 1.11 \times 0.7283$

$\alpha = 0.73$

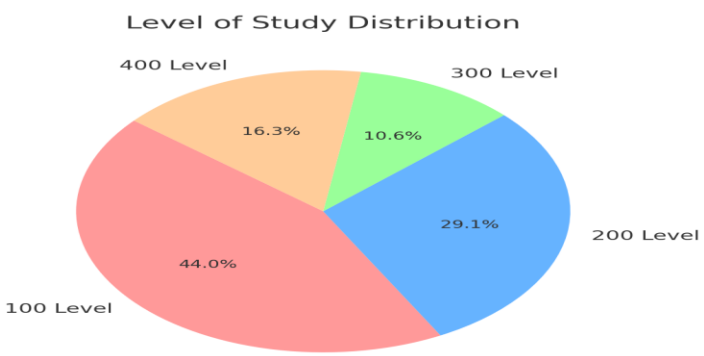
Thus, Cronbach's Alpha = 0.73, which indicates acceptable reliability.

APPENDIX IV

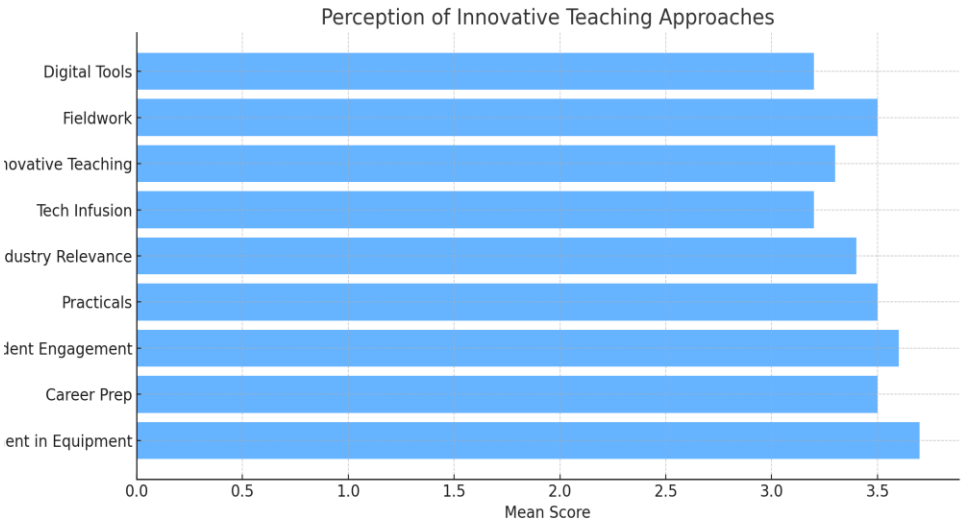
DATA ANALYSIS

Gender Distribution: 58.9% of respondents were female, while 41.1% were male, indicating a female majority.

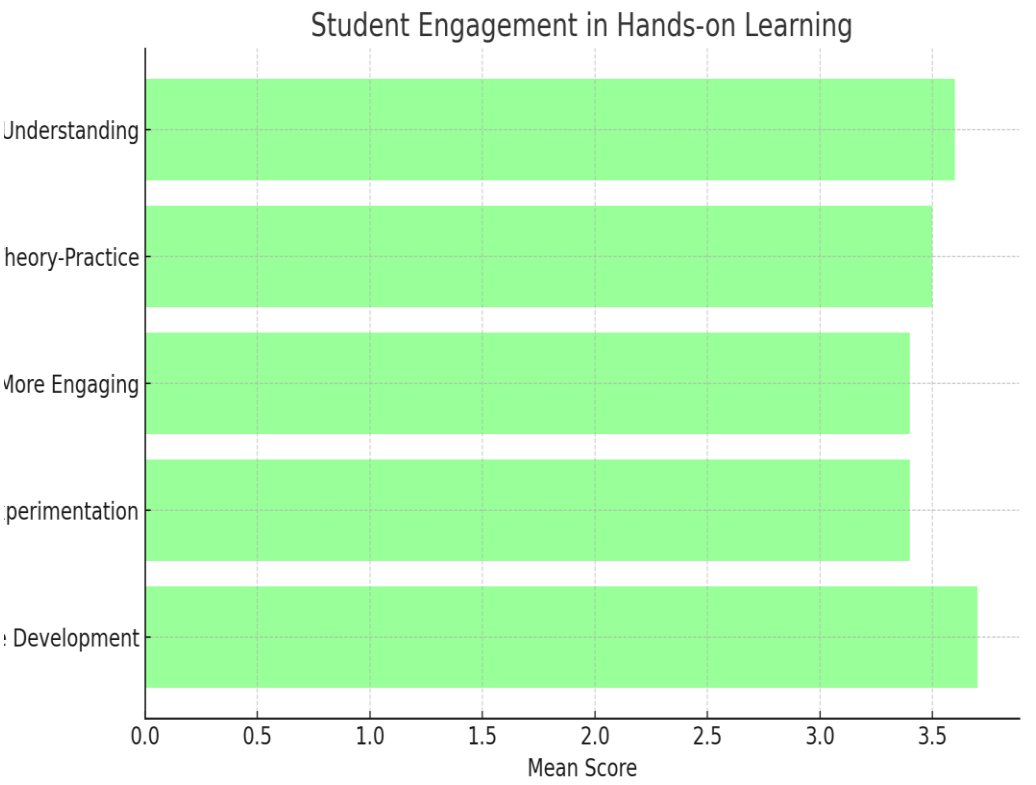
Level of Study: The largest group was first-year students (43.9%), followed by second-year (29.0%), final-year (16.3%), and third-year students (10.6%).



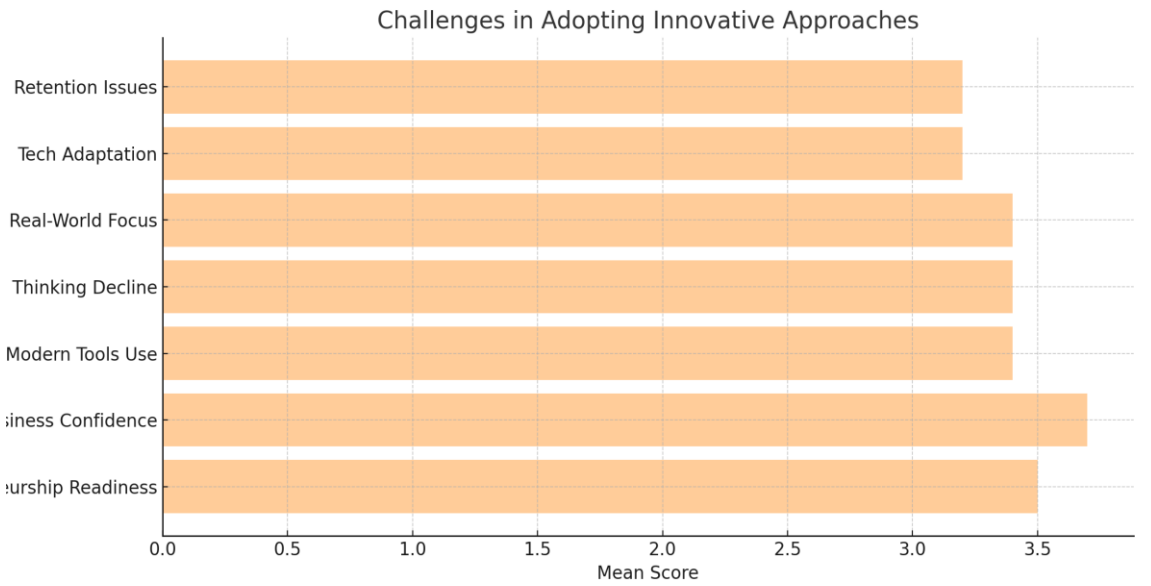
1. Perception of innovative approaches to teaching and learning



2. Students Engagement in Hands-on Learning



3. Challenges in adopting innovative approaches



4. Strategies for improving innovative approaches