The Influence of Education 4.0 on Decision-making and Agripreneurship Start-up Behavior among Agriculture Students in Kenyan TVET Institutions

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Abstract: This study examined the impact of Education 4.0 on decision-making processes and agripreneurship among agriculture students in Kenyan TVET institutions. The researchers conducted a systematic literature review following PRISMA guidelines, utilizing databases such as PubMed, Scopus, and Google Scholar, resulting in a final sample of 54 articles. The selected studies explored Education 4.0's influence on agricultural education, decision-making skills and agripreneurship behavior among TVET students. Articles included in the review met specific inclusion criteria: focus on Education 4.0's impact, involvement of agriculture students, publication in peer-reviewed journals, written in English and inclusion of empirical research or theoretical papers. Findings highlight that Education 4.0 initiatives, including technological integration and agripreneurship skill development, enhance students' abilities to make informed decisions and pursue agripreneurship opportunities in agriculture. Technological tools such as drones, GIS, GPS and AI play a crucial role in improving crop and livestock management, thereby facilitating better decision-making in agricultural practices. In conclusion, Education 4.0 significantly shapes decision-making processes and agripreneurship among TVET agriculture students. Recommendations include prioritizing investments in digital infrastructure, supporting educator training, and fostering industry partnerships to maximize the benefits of Education 4.0 in agricultural education. The implications extend to various stakeholders in agricultural education and entrepreneurship, guiding educators, policymakers, and students in leveraging Education 4.0 for enhanced learning and agripreneurship development.

Keywords: Education 4.0; agricultural education; decision-making; agripreneurship; technological integration; TVET institutions.

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Introduction

While the agricultural sector plays a pivotal role in the economies of developing countries, Kenya is no exception. Agriculture serves as a cornerstone of the Kenyan economy, contributing significantly to employment, food security and overall economic growth (Lusui, 2023). In Kenya, agriculture accounts for approximately 33% of the country's gross domestic product (GDP) and employs over 50% of the labor force (Nyoro, 2019). Agriculture serves as a primary source of livelihood for millions of Kenyans, particularly those residing in rural areas, where agriculture is the main economic activity. The sector encompasses a wide range of activities, including crop production, livestock farming, fisheries and forestry, which collectively contribute to the country's food production, export earnings and rural development initiatives (Ghosh et al., 2020).

However, despite its importance, the agricultural sector in Kenya faces numerous challenges that hinder its full potential and which impacts on the economy. Limited access to markets is a significant constraint, particularly for smallholder farmers, who often struggle to access reliable markets to sell their produce at fair prices (Autio et al., 2021). Inadequate infrastructure, including poor road networks, limited storage facilities and inadequate irrigation systems, further exacerbates the challenges faced by farmers in accessing markets and transporting their produce to urban centers (OnyekaEzealaji, 2019). Climate change poses another significant challenge to the agricultural sector in Kenya, with erratic weather patterns, prolonged droughts and unpredictable rainfall affecting crop yields, livestock productivity and overall agricultural production.

These challenges not only affect the productivity and efficiency of agricultural activities but also pose obstacles to the development of agripreneurship initiatives within the country. Agripreneurship is the process of creating, managing and growing agricultural ventures through innovative and entrepreneurial approaches, leveraging advanced technologies and business practices to enhance agricultural productivity and sustainability. Despite the challenges, there is a growing recognition of the potential of agripreneurship to drive innovation, create employment and foster economic development in Kenya (Ouko et al., 2022). Agripreneurs play a crucial role in transforming the agricultural sector by introducing innovative technologies, value-added products and market-driven approaches to farming (Arumugam & Manida, 2023). Moreover, agripreneurship offers opportunities for young people to engage in profitable and sustainable agricultural enterprises, thereby addressing the youth unemployment challenge and contributing to poverty reduction and food security in the country.

In response, Technical and Vocational Education and Training (TVET) institutions play a crucial role in the educational landscape of Kenya, particularly in preparing students for careers in various industries, including agriculture (Muchira et al., 2023). The TVET institutions are designed to provide practical skills training and technical knowledge to students, equipping them with the competencies needed to succeed in specific trades and professions (Tuan & Cuong, 2019). In Kenya, TVET institutions were introduced as part of the government's efforts to address the skills gap in the labor market and promote socio-economic development (Chepkoech, 2021). These institutions offer a wide range of vocational courses and programs tailored to meet the needs of different industries, including agriculture, manufacturing, construction, and hospitality.

One of the primary objectives of TVET institutions in Kenya is to promote industry 4.0 through the Education 4.0 initiatives (Musyimi, 2021). Industry 4.0, also known as the Fourth Industrial Revolution, refers to the integration of digital technologies, automation and data-driven processes in manufacturing and other industries (Grech & Camilleri, 2020). Education 4.0, a concept derived from Industry 4.0, aims to prepare students for the demands of the Fourth Industrial Revolution by incorporating digital technologies, innovative pedagogies and industry-relevant skills training into the education system (Singh & Sharma, 2019). TVET institutions in Kenya are at the forefront of implementing Education 4.0 initiatives to equip students with the technical skills, digital literacy, and agripreneurship mindset needed to thrive in the rapidly evolving industrial landscape.

The TVET institutions in Kenya play a critical role in bridging the gap between education and industry. This is accomplished through offering practical, hands-on training that is aligned with the needs of the labor market (Wahungu et al., 2023) Through partnerships with industry stakeholders, TVET

institutions collaborate with employers to develop curriculum, provide work-integrated learning opportunities and facilitate skills development programs that meet industry standards and demands (Wahungu et al., 2023). By aligning their programs with the requirements of industry 4.0, TVET institutions in Kenya are able to produce graduates who are not only technically proficient but also adaptable, innovative and equipped with the digital skills needed to succeed in today's technology-driven economy.

Education 4.0 plays a significant role in TVETs by shaping the curriculum and instructional methods to promote agrienterprise aspects among students (Tandon et al., 2020). The TVET institutions leverage various components of Education 4.0 to equip students with the necessary knowledge and skills for agripreneurship. Digital technologies such as e-learning platforms, virtual reality simulations and mobile applications are integrated into the curriculum to provide students with interactive and immersive learning experiences in agricultural practices, market trends and business management. In addition, innovative pedagogies, including experiential learning, project-based learning and competency-based training, are adopted to engage students in real-world agricultural projects and agripreneurship ventures, where they can apply theoretical knowledge to practical scenarios and develop critical thinking and problem-solving skills (Neumeyer & Santos, 2023). Moreover, TVET institutions prioritize industry-relevant skills training by partnering with agricultural enterprises, agribusiness associations and government agencies to offer work-integrated learning opportunities, internships, and apprenticeships that expose students to the latest technologies, practices, and market trends in the agricultural sector (Hanafi et al., 2023).

This study sought to explore the influence of Education 4.0 on decision-making and agripreneur start-up behavior among agriculture students in Kenyan TVET institutions.

Literature Review

The literature review centers around several key themes, including evolution of education 4.0 in TVET institutions, integration of digital technologies in agricultural education and challenges and barriers to implementing education 4.0 in learning institutions. The section presents the conceptual and theoretical underpinnings that depicts the study variables.

Evolution of Education 4.0 in TVET Institutions: Trends and Adoption

The evolution of Education 4.0 within Technical and Vocational Education and Training (TVET) institutions marks a significant departure from traditional teaching methods, as it embraces digital technologies and innovative pedagogical approaches to enhance vocational education. According to Shamkuwar and Sharma (2023), Education 4.0 signifies a paradigm shift in teaching and learning, where digital technologies like artificial intelligence (AI), machine learning (ML) and virtual reality (VR) are leveraged to augment educational experiences (Shamkuwar & Sharma, 2023). Advancements in technology play a pivotal role in driving the adoption of Education 4.0 in Kenyan TVET institutions. With rapid advancements in digital technology, there is a growing recognition of the importance of integrating these technologies into vocational education to better prepare students for the modern workforce (Qureshi et al., 2021). Additionally, the accessibility and affordability of digital devices and internet connectivity have improved significantly in recent years, making it feasible for TVET institutions to embrace Education 4.0 initiatives (Grech & Camilleri, 2020).

Furthermore, changing workforce demands contribution to the adoption of Education 4.0 in TVET institutions. As industries evolve and become increasingly reliant on digital technologies, there is a growing demand for skilled workers who possess proficiency in areas such as digital literacy, data analysis, and problem-solving (Laar et al., 2019). Incorporating Education 4.0 principles into their curriculum, TVET institutions can better align their programs with the evolving needs of industries, thereby enhancing the employability of their graduates (Chepkoech, 2021). Government initiatives also play a crucial role in driving the adoption of Education 4.0 in TVET institutions in Kenya. Recognizing the importance of modernizing vocational education to support economic growth and development, the government has implemented various policies and programs aimed at promoting the integration of digital technologies and innovative pedagogical approaches in TVET institutions (Ovcharuk et al., 2020). These initiatives include the provision of funding, training programs for educators and partnerships with industry stakeholders to facilitate the adoption of Education 4.0 (Onyango et al., 2022).

Integration of Digital Technologies in Agricultural Education

E-learning platforms have become increasingly prevalent in agricultural education, offering students access to a wide range of educational resources, interactive modules and collaborative learning opportunities. Platforms such as Moodle and Google Classroom allow instructors to deliver course materials, assignments and assessments online, enabling students to engage with the curriculum at their own pace and convenience (Prasetya, 2022). These platforms also facilitate communication and collaboration among students and instructors, fostering a dynamic learning environment that promotes active participation and knowledge sharing (Barman & Karthikeyan, 2019).

Virtual simulations offer a unique opportunity for students to gain hands-on experience in agricultural practices and decision-making within a controlled, virtual environment (Stohlmann, 2019). These simulations replicate real-world scenarios, allowing students to explore different agricultural techniques, experiment with crop and livestock management strategies, and assess the impact of their decisions on farm productivity and sustainability (Basche et al., 2021). Virtual simulations also enable students to practice problem-solving skills, critical thinking, and risk assessment in a safe and immersive setting, preparing them for the complexities of real-world agricultural challenges (Dayarathna et al., 2021). Additionally, virtual simulations can be customized to align with specific learning objectives and outcomes, ensuring that students develop the practical skills and competencies required for success in agripreneurship in establishing market gaps and demands (Srishailam et al., 2022).

Mobile applications have emerged as valuable tools for accessing agricultural information, resources and services on the go. These applications provide farmers and agricultural practitioners with access to weather forecasts, market prices, pest and disease management advice and agricultural extension services, empowering them to make informed decisions and optimize their farming practices (Kumar & Karthikeyan, 2019). For agricultural students, mobile applications offer opportunities to engage with real-world agricultural challenges, explore innovative solutions and connect with industry professionals and experts (Narisetti, 2020).

The integration of digital technologies in agricultural education has a profound impact on student learning outcomes, practical skills development and agripreneurship readiness. E-learning platforms provide students with access to a diverse range of educational resources, collaborative learning opportunities, and flexible learning pathways, enhancing their engagement and retention of agricultural knowledge and skill (Adeshola & Agoyi, 2023). Virtual simulations enable students to gain hands-on experience in agricultural practices and decision-making within a safe and controlled environment, preparing them for the complexities of real-world agricultural challenges (Vigoroso et al., 2021).

Theoretical Underpinnings

This study focuses in the Ecological Systems Theory (EST) developed by Urie Bronfenbrenner. It helps readers and practitioners to understand human development and behavior within interconnected environmental systems (Yang & Sanborn, 2021). The EST emphasizes the influence of multiple environmental layers on individuals, ranging from immediate interactions to broader societal contexts. This theoretical framework is particularly relevant in exploring the complexities of decision-making processes and agripreneurship among agriculture students in Kenyan TVET institutions (Mulisa, 2019). At the microsystem level, comprising immediate environments where individuals directly interact, such as families, peers and schools, students' decision-making and agripreneurial aspirations are shaped by their daily educational experiences (Tudge et al., 2022). Interactions with peers, instructors and educational resources within TVET institutions influence students' attitudes, skills and perceptions regarding agripreneurship opportunities and the decision-making involved in pursuing such ventures.

Moving to the mesosystem, which entails the interconnections between different microsystems, the study examines how interactions across various settings influence students' decision-making and agripreneurial behavior (Adeyanju et al., 2023). For instance, the relationship between students' educational experiences and their family dynamics or community networks may influence their agripreneurial aspirations. Positive interactions and support from family, mentors or industry stakeholders can foster students' confidence and readiness to engage in agripreneurship.

Within the exosystem, which encompasses external environments indirectly influencing individuals, factors like government policies, economic conditions and societal attitudes toward entrepreneurship play crucial roles. Changes in policies promoting entrepreneurship or economic shifts affecting agricultural markets can shape students' perceptions of agripreneurship viability and the feasibility of their decision-making regarding entrepreneurial ventures (Thephavanh, 2023). The macrosystem represents the broader cultural, social and economic contexts influencing individuals' experiences and opportunities. Within this context, cultural values, societal norms and economic disparities influence students' perceptions of agripreneurship as a career path and the resources available for pursuing entrepreneurial endeavors in the agricultural sector. The chronosystem underscores the role of time and historical context in shaping individuals' development and experiences (Sadownik, 2023). It acknowledges the evolving landscape of education, technology and entrepreneurship within the

agricultural sector, which may influence students' decision-making and agripreneurial behavior over time. Historical events, technological advancements or shifts in educational paradigms may influence students' access to resources, exposure to entrepreneurial opportunities and overall entrepreneurial trajectories.

Conceptual Framework

The Stimulus-Organism-Response (SOR) model provides a comprehensive framework for understanding the influence of Education 4.0 on decision-making processes and agripreneurship among agriculture students in TVET institutions. This model posits that external stimuli elicit responses from organisms, which in turn influence their behavior and cognitive processes (Kim et al., 2020). In the context of this study, Education 4.0 serves as the stimulus (S), agriculture students in TVET institutions represent the organisms (O) and decision-making processes and agripreneurship constitute the responses (R).
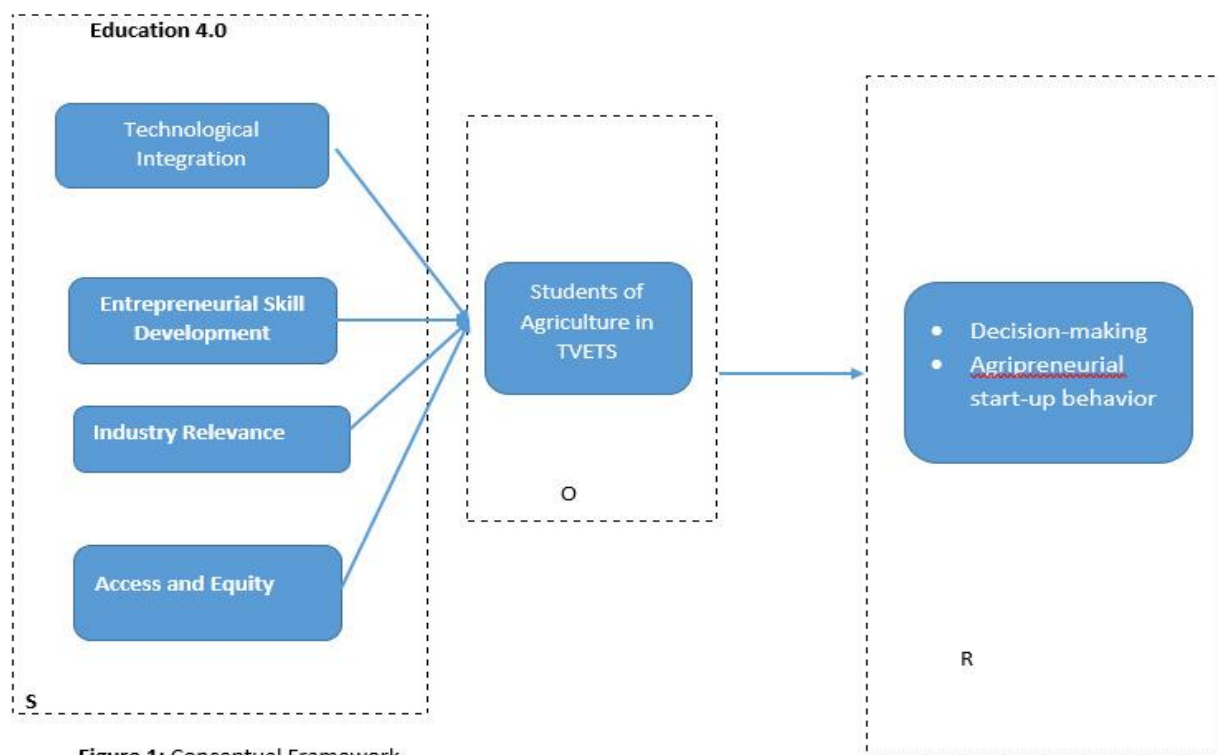

Figure 1: Conceptual Framework

The stimulus (S) in this study refers to Education 4.0, which encompasses various components aimed at enhancing learning experiences and fostering agripreneurship skills among agriculture students. Education 4.0 stimulates technological integration

by incorporating digital tools such as drones, GIS, GPS, and AI into agricultural education. It also facilitates agripreneurship skill development through business management simulations, agripreneurship modules and technology business

incubators. Moreover, Education 4.0 ensures industry relevance by aligning educational content with industry needs and trends in agriculture. Additionally, it promotes access and equity by providing equitable access to educational resources and technology infrastructure for all students in TVET institutions.

The response (R) in this study encompasses decision-making processes and agripreneurship among agriculture students. Decision-making involves utilizing technological solutions and data-driven insights for crop management, resource allocation and risk management in agriculture. It also entails applying agripreneurship decision-making frameworks to identify opportunities and address challenges within the agricultural sector. Agripreneurship, on the other hand, involves developing business management skills, engaging in agripreneurship activities, and contributing to the growth and sustainability of the agricultural sector through innovative ventures and initiatives. The relationship between the S, O and R variables in the SOR model is dynamic and reciprocal. Education 4.0 serves as the external stimulus that influences the cognitive processes and behaviors of agriculture students (organisms). These students, in turn, respond to the stimulus by engaging in decision-making processes informed by technological advancements and agripreneurship skills acquired through Education 4.0 initiatives. The interaction between the stimulus, organisms and responses shapes the learning experiences and entrepreneurial behaviors of agriculture students in TVET institutions, ultimately contributing to their professional development and the advancement of the agricultural sector.

Methodology
Study Design
This study employed the systematic literature review approach, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The objective was to examine the influence of Education 4.0 on decision-making processes and agripreneurship start-up behavior among agriculture students in Kenyan TVET (Technical and Vocational Education and Training) institutions.
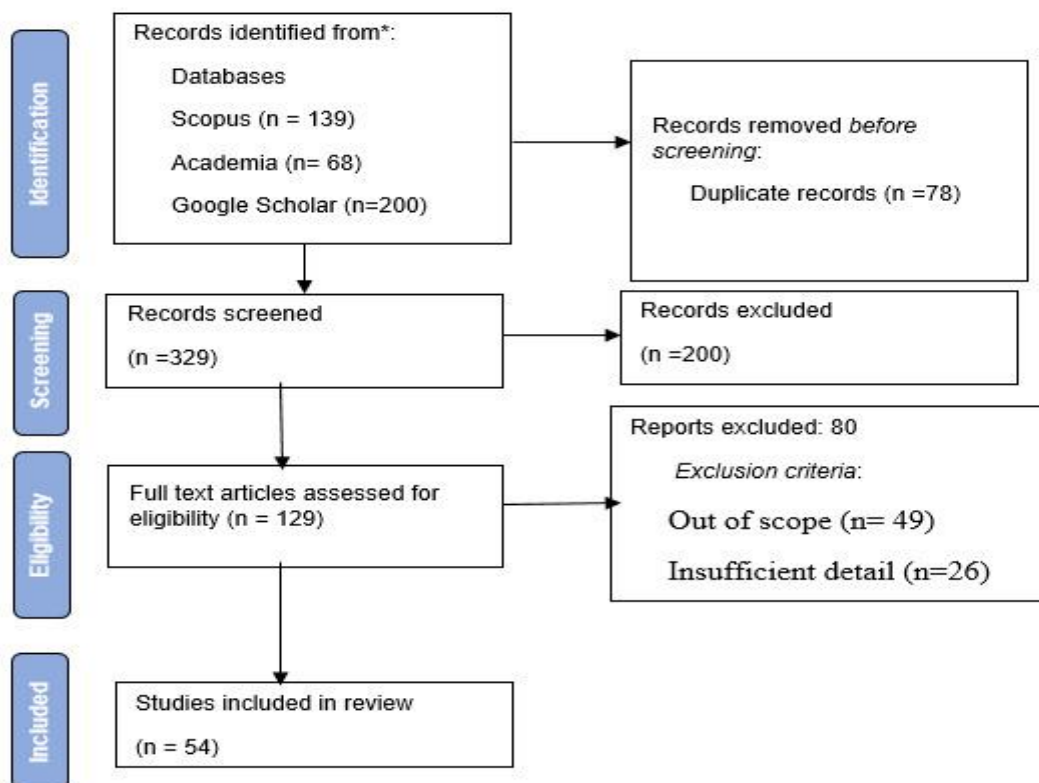

Figure 2: Flow diagram illustrating the systematic review process following PRISMA guidelines

Search Strategy

A systematic search of relevant literature was conducted across various electronic databases, including, Scopus, Web of Science, and Google Scholar. The search strategy involved the use of keywords such as "Education 4.0," "decision making," "agripreneurship," "start-up behavior," "agriculture students" and "TVET institutions." Boolean operators were utilized to refine the search results. The search was limited to articles published in English between 2018 and the present.

Inclusion and Exclusion Criteria

Articles were included in the review if they met the following criteria: (a) focused on the impact of Education 4.0 on decision-making processes and agripreneurship start-up behavior, (b) involved agriculture students in learning institutions, (c) were published in peer-reviewed journals, (d) written in English, and (e) included empirical research, theoretical papers, or systematic reviews. Articles that did not meet these criteria or were duplicates were excluded.

Data Collection and Analysis

Initially, the selected articles were screened based on their titles and abstracts to determine their relevance. Full texts of the relevant articles were then retrieved and assessed for eligibility based on the inclusion and exclusion criteria. Data extraction was conducted, focusing on key aspects such as authors, publication year, research design, sample characteristics, methodologies employed and findings related to the impact of Education 4.0 on decision-making processes and agripreneurship start-up behavior among agriculture students.

Results and Discussion

This section presents an analysis and discussion of the results on the influence of Education 4.0 technologies on agriculture students in Kenyan Technical and Vocational Education and Training (TVET) institutions. Specifically, it examines how these technologies affect decision-making processes and the development of agripreneurship skills among students. The findings highlight the significant impact of advanced technological tools and educational interventions in enhancing students' skills and knowledge, ultimately preparing them for entrepreneurial success in the agricultural sector.

Theme 1: Influence of Education 4.0 Technologies on Decision-Making Processes among Agriculture Students in Kenyan TVET Institutions.

The integration of Education 4.0 technologies into agricultural education has shown significant impacts on decision-making processes among agriculture students in Kenyan Technical and Vocational Education and Training (TVET) institutions. Studies demonstrate that incorporating advanced technological tools like GPS, artificial intelligence (AI), drones and the Internet of Things (IoT) into the curriculum enhances students' skills in crop management, livestock management, and precision agriculture.

For instance, the utilization of GPS technology aids in decision-making processes related to crop monitoring, disease mapping and optimal resource allocation in agriculture. Mhlanga (2021) highlighted the pivotal role of AI in improving crop management practices and food security through AI-enabled tools. These tools enhance agricultural productivity in rural areas by providing solutions for pest control, disease detection and crop management, leading to improved crop yields and food security. Furthermore, the integration of drones into agricultural education, as explored by Okubo et al. (2022) and Bolick et al. (2022), significantly influences decision-making processes. Drones enhance students' understanding of technology in agriculture and facilitate hands-on learning experiences related to UAV data acquisition and processing. Okubo et al. (2022) found that programming education using drones reminded students of the necessity of technology in agriculture, particularly in rice cultivation, and fostered a sense of participation in agricultural practices. Similarly, Bolick et al. (2022) reported that UAV laboratory exercises effectively taught students about UAV data acquisition and processing, with an average quiz score of 92% and positive student feedback on engagement and effectiveness. This exposure to innovative technologies at an early age shapes students' perceptions of technology in agriculture, ultimately influencing their decision-making abilities.

Additionally, educational interventions, such as business management simulations and Business Simulation Games (BSGs) play a crucial role in fostering entrepreneurial decision-making skills in agriculture. Brown and Knobloch (2022) demonstrated that students taught with business

management simulations had higher business management knowledge compared to those taught using traditional methods. These simulations engage students in real-life contexts, providing practical experiences that promote higher-order thinking skills essential for informed decision-making within the agricultural domain. Huang et al. (2022) found that integrating BSGs into a flipped classroom environment enhanced student engagement, learning outcomes and higher-order thinking skills, such as problem-solving, critical thinking, and creativity. This approach promotes student-centered learning and skill development in entrepreneurship education.

Moreover, the establishment of technology business incubators at universities has been found to significantly contribute to the development of entrepreneurial skills among students. Novanda (2022) explored the impact of support variables on the initiation of a technology business incubator at Bengkulu University in Indonesia. The study identified five crucial support variables: access partnership programs, professional network access, technology access, access to international relations and job creation. These factors significantly affect the establishment of business incubators, providing students with essential resources and support to develop their entrepreneurial skills. Novanda's findings underscore the importance of these support structures in fostering entrepreneurship development within the agricultural sector.

Participation in agripreneurship empowerment programs has also shown positive impacts on young agripreneurs' skills. Adeyanju et al. (2023) investigated factors driving participation in these programs and their impact on agripreneurship skills among young agripreneurs in Kenya, Nigeria, and Uganda. The study revealed that factors such as age, education, agripreneurship experience, business level, current residence, and training perception significantly influenced participation. Participants exhibited higher agripreneurship skills scores than non-participants, demonstrating the positive and significant impact of these programs on skills development. The findings highlight the importance of raising awareness of agribusiness opportunities and equipping students with the necessary skills for entrepreneurial success in agriculture.

The integration of smart farming technologies into agricultural education programs further emphasizes the importance of technological advancements in agricultural decision-making. Raji and Amadi (2023) explored how agricultural AI, IoT and precision agriculture could be integrated into educational curricula in tertiary institutions in Rivers State, Nigeria. Their study revealed agreement among lecturers, extension officers and students on various integration methods. Recommendations included organizing workshops for lecturers, providing farm IoT devices and implementing precision agriculture practices through real-life demonstrations to engage learners and enhance their decision-making abilities. Similarly, the development of a cloud-based system for educating students within the Industry 4.0 paradigm, as described by Mijailović et al. (2021), provides practical experiences and individual learning paths that facilitate decision-making processes. This system, designed for monitoring and managing agriculture and ecology fields, enables benchmarking, simulation, and verification, thus improving students' knowledge of sensor applications in natural conditions and contributing to product quality and profit.

Theme 2: Impact of Education 4.0 on the Development of Agripreneurship Skills among Agriculture Students in TVET Institutions.

Education 4.0 components have a profound impact on fostering agricultural entrepreneurship among students, as indicated by various studies. Initiatives such as business management simulations and Business Simulation Games (BSGs) have been demonstrated to effectively enhance students' entrepreneurial skills and knowledge in agricultural contexts. Brown and Knobloch (2022) and Huang et al. (2022) highlighted the significance of these educational interventions, which provide students with practical experiences and promote higher-order thinking skills essential for entrepreneurial decision-making in the agricultural sector.

Business management simulations and BSGs allow students to engage in real-life scenarios, helping them develop essential skills in problem-solving, critical thinking, and creativity. For instance, Huang et al. (2022) found that the use of BSGs in a flipped classroom setting significantly improved student engagement, learning achievement and higher-order thinking skills. These skills are crucial for students to navigate the complexities of agricultural entrepreneurship, making informed decisions that drive innovation and efficiency in their agribusiness ventures.

Moreover, the establishment of technology business incubators at universities contributes significantly to the development of entrepreneurial skills among students. Novanda's (2022) exploration of technology business incubators underscored the crucial role of institutional support structures, including funding and professional services, in fostering entrepreneurship development within the agricultural sector. These incubators provide a supportive environment, where students can access resources, mentorship, and networks essential for starting and growing agribusinesses. The presence of such incubators at universities equips students with the practical skills and knowledge needed to transform their ideas into viable businesses.

Participation in agripreneurship empowerment programs also positively influences young agripreneurs' skills, as evidenced by Adeyanju et al. (2023). These programs raise awareness of agribusiness opportunities and equip students with the necessary skills for entrepreneurial success in agriculture. Adeyanju et al. (2023) found that factors such as age, education, agripreneurship experience and training perception significantly influenced participation in these programs. Participants in agripreneurship empowerment programs had higher agripreneurship skills scores than non-participants, indicating the effectiveness of these initiatives in enhancing entrepreneurial capabilities among young agripreneurs in Africa.

The integration of smart farming technologies into agricultural education programs further enhances students' entrepreneurial skills and knowledge. Raji and Amadi (2023) demonstrated how hands-on experiences and relevant resources provided by institutions prepare students for entrepreneurial decision-making in a high-tech agricultural landscape. They explored various methods for integrating agricultural artificial intelligence (AI), the Internet of Things (IoT) and precision agriculture into educational programs, highlighting the importance of real-life demonstrations in school farms. These experiences help students understand and apply advanced technologies in agriculture, fostering a sense of innovation and readiness to tackle modern agricultural challenges.

Additionally, Okubo et al. (2022) and Bolick et al. (2022) have shown the importance of integrating drone technology into agricultural education. Okubo et al. (2022) found that programming education using drones significantly enhanced students'

understanding of the necessity of using technology in agriculture. This approach not only fostered critical thinking about the role of technology in future agricultural practices but also provided hands-on experience in using drones for crop management. Similarly, Bolick et al. (2022) demonstrated that Unmanned Aerial Vehicle (UAV) education modules and laboratory exercises effectively taught students about UAV data acquisition and processing, further enhancing their technological competencies and readiness for agricultural entrepreneurship. Although Mijailović et al. (2021) did not directly address agricultural entrepreneurship, their emphasis on practical experiences and individual learning paths aligns with the broader goal of equipping students with the skills and knowledge necessary for entrepreneurial success across various domains, including agriculture. Their study on the development of a cloud-based system with microcontroller platforms highlighted the importance of practical experiences in student education, which can be applied to enhance students' understanding of digitalization and Industry 4.0 in agriculture.

Conclusions s and Implications
Conclusions
The study concludes that Education 4.0 emerges as a transformative force in shaping decision-making processes and fostering agripreneurship among agriculture students in TVET institutions. The integration of advanced technologies like drones, GIS, GPS and AI enhances students' proficiency in agricultural management and cultivates entrepreneurial competencies, essential for navigating modern agricultural challenges. Through equipping students with these technological competencies and fostering industry-relevant skills, Education 4.0 prepares them to make informed decisions and seize agripreneurship opportunities effectively. This paradigm shift underscores the critical role of digital literacy and innovative pedagogies in agricultural education, paving the way for sustainable agricultural practices and economic growth.

Implications
The implications of this study extend to various stakeholders involved in agricultural education and entrepreneurship in Kenyan TVET institutions. Educators can leverage the findings to design and implement effective Education 4.0 initiatives that promote hands-on learning experiences and foster

entrepreneurial skills among students. Policymakers and institutional leaders can use the insights to allocate resources and develop support structures, such as technology business incubators and agripreneurship empowerment programs, to facilitate entrepreneurship development in the agricultural sector. Furthermore, students can benefit from the awareness raised about the opportunities available in agribusiness and the acquisition of relevant skills for entrepreneurial success.

Suggested Further Research

To further advance the understanding of the impact of Education 4.0 on agricultural decision-making and entrepreneurship, several avenues for future research can be explored. Empirical studies can be conducted to assess the effectiveness of specific Education 4.0 initiatives, such as drone-based agricultural training programs or technology business incubators in enhancing students' entrepreneurial skills and start-up behavior. Longitudinal studies can track students' progress over time to evaluate the long-term effects of Education 4.0 on their career trajectories in the agricultural sector. Additionally, comparative studies can be conducted to assess the differences in Education 4.0 implementation across different TVET institutions and identify best practices for promoting agricultural entrepreneurship in Kenya.

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