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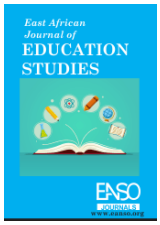

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Original Article

Developing Life Skills through Science Education: Enhancing Values and Communication for Holistic Learner Growth

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ABSTRACT

Life skills are essential competencies that empower learners to effectively navigate personal, academic, and societal challenges. This article examines the definition, categories, values, and benefits of life skills within the context of science education. It highlights three core categories: intrapersonal skills (living with oneself), interpersonal skills (living with others), and cognitive-critical thinking skills (making effective decisions). The review explores key values that underpin life skills such as empathy, responsibility, integrity, and inclusivity and outlines the diverse benefits these competencies bring to science teaching, including improved academic achievement, civic engagement, and emotional resilience. Methodologically, the article is based on a qualitative integrative review of literature published between 2015 and 2025. Thematic analysis was conducted using a multi-stage coding process: open coding to identify emergent themes, axial coding to relate these themes to pedagogical strategies like inquiry-based learning, collaborative projects, reflective practices, and ICT integration, and selective coding to derive fifteen specific roles that science tutors and lecturers play in nurturing life skills among student teachers in Uganda. These roles include mentorship, role modelling, curriculum integration, inclusive pedagogy, and ethical leadership. The article concludes by emphasising the implications for science education and teacher training, providing practical guidance for educators to equip learners with holistic competencies necessary for sustainable development and transformative citizenship.

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INTRODUCTION

Life skills are defined as abilities that enable individuals to deal effectively with the demands and challenges of everyday life (WHO, 2025a). These skills encompass a broad range of cognitive, emotional, and social competencies that support learners in managing themselves, relating well to others, and making informed decisions. In educational settings, particularly within science classrooms, life skills development is critical because science learning inherently involves inquiry, experimentation, communication, and ethical considerations.

Three broad categories of life skills are recognised: skills for living with oneself (such as self-awareness and emotional regulation), skills for living with others (including empathy and cooperation), and skills for making effective decisions (like critical thinking and problem-solving) (UNESCO, 2025a). Science teachers are uniquely positioned to foster these skills through a variety of strategies, including collaborative experiments, group discussions, reflective activities, and the integration of real-world problem-solving.

Additionally, embedding values such as respect, responsibility, honesty, and perseverance alongside clear behavioural indicators enhances the effectiveness of life skills education. Communication plays a pivotal role in this process by facilitating understanding, engagement, and ethical dialogue in science classrooms. Research underscores the multiple benefits of effective communication, from improving academic outcomes to promoting social inclusion and motivation.

Given these insights, this article aims to provide educators and stakeholders with a well-rounded framework for integrating life skills development into science teaching, thus contributing to the formation of competent, ethical, and socially responsible learners.

RATIONALE

In an increasingly complex and dynamic world, equipping learners with life skills is fundamental for their success both inside and outside the classroom. Life skills such as critical thinking, communication, adaptability, and collaboration are essential in navigating personal, academic, and professional challenges (World Health Organisation [WHO], 2020). Science education offers a unique platform for nurturing these competencies because of its emphasis on inquiry-based learning, evidence-based reasoning, and collaborative experimentation (Bybee, 2020a). The integration of life skills into

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science teaching aligns with contemporary educational priorities, such as fostering 21st-century competencies and preparing students for global citizenship (UNESCO, 2019). However, this integration is often overlooked or underemphasised, limiting learners' holistic development and the applicability of their knowledge in real-life contexts (Bozkurt & Sharma, 2020). This article addresses this gap by providing a comprehensive overview of life skills, their categories, practical strategies for their development and the role of tutors in developing life skills within science education. By articulating clear values and indicators alongside the benefits of effective communication, this article advocates for a purposeful approach to teaching science, one that transcends content knowledge and fosters skills vital for personal and social well-being (Trilling & Fadel, 2018; OECD, 2021a).

METHODOLOGY

Researchers carried out a qualitative integrative review of the literature to understand how life skills are defined, valued, and fostered within science education, especially within Uganda.

The search strategy targeted databases such as ERIC, JSTOR, and Google Scholar, using terms like *life skills education*, *critical thinking*, *science teacher development in Uganda*, and *intrapersonal/interpersonal skills*. Researchers prioritised research that was empirical or theoretically rich, focused on science or teacher training, and rooted in sub-Saharan Africa or the Ugandan context. This approach is consistent with recent systematic work exploring life skills education in school settings (Hynes et al., 2018).

To structure our analysis, researchers drew on the widely referenced WHO/UNESCO classification, grouping skills into intrapersonal (e.g., self-awareness, resilience), interpersonal (empathy, teamwork), and cognitive–critical thinking (decision-making, problem-solving). These categories align closely with 21st-century competence frameworks (National Research Council, 2012). Recognising that values like responsibility, integrity, and inclusivity are integral to life skills, our thematic coding sought out how different studies framed and emphasised these ethical dimensions.

Researchers explicitly examined contextual materials, including Uganda's National Teacher Policy and the competence-based science curriculum. In particular, the new curriculum strongly emphasises inquiry, collaboration, and digital integration elements, echoed by the Uganda Professional Science Teachers' Union (2023). The research also incorporated mixed-methods and cluster-randomised studies, such as Ssenyonga et al.'s (2022) work on whether digital interventions support critical thinking about health, as well as a teacher-led life skills intervention in secondary schools that showed gains in self-efficacy and emotional wellbeing (Betancourt et al., 2018), and Giussani Foundation's action research on teacher coaching for critical thinking (2023).

Methodologically, the review employed a multi-stage analytical approach to ensure a comprehensive and nuanced understanding of life skills integration in science education. The first stage involved open coding**,** which allowed us to identify emerging themes across various sources related to the three main life skill domains: intrapersonal, interpersonal, and cognitive-critical thinking skills. This initial step helped us uncover key patterns in how life skills are discussed and conceptualised in both educational research and policy documents.

The second stage was axial coding, which enabled the team to explore the connections between the identified life skills and specific pedagogical strategies used in science education. These strategies included inquiry-based learning, collaborative projects, reflective journaling, and the integration of digital technologies. By linking skills to methods, we could assess not only what life skills are valued but also how they are being actively cultivated in the classroom.

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Finally, in the selective coding stage, researchers synthesised the findings to articulate fifteen specific roles that science tutors and lecturers play in fostering life skills among student teachers. These roles ranged from mentorship and role-modelling to more formal responsibilities such as curriculum integration, inclusive pedagogy, and ethical leadership. This structured coding process allowed us to organise diverse sources into a coherent framework that reflects both the theory and practice of life skills education within the Ugandan science teaching context.

To validate and triangulate the study findings, the team aligned case-study evidence (e.g., Ssenyonga et al., 2022; Giussani Foundation, 2023) with policy directives and broader international frameworks (Hynes et al., 2018; National Research Council, 2012). For instance, Uganda's competence-based curriculum encourages digital tools to develop critical thinking, a trend confirmed by evidence on digital interventions improving health-related decision-making (Ssenyonga et al., 2022).

Ultimately, by weaving together international life-skills frameworks, localised policy analysis, empirical research, and classroom-level case studies, our methodology offers a rich, evidence-based synthesis of strategies to promote holistic science education in Uganda over the past decade.

FINDINGS

Emerging Themes in Life Skills Integration within Science Education

Definition of Life Skills in the Context of Science Teaching

In the context of science teaching, a life skill refers to a competency or ability that enables learners to effectively deal with the demands and challenges of everyday life through scientific understanding and application. These skills extend beyond academic content to encompass attitudes, values, and behaviours that support informed decision-making, critical thinking, collaboration, communication, empathy, and responsible action in both personal and societal contexts (UNESCO, 2021a; WHO, 2021). For example, skills such as problem-solving, analytical thinking, environmental stewardship, and health literacy are crucial in helping learners address issues like climate change, disease prevention, and technological innovation (OECD, 2021b; Trilling & Fadel, 2018). Life skills in science education empower learners not only to grasp scientific content but also to apply scientific reasoning and ethical judgment to real-world problems, fostering both academic achievement and social responsibility (Bybee, 2020b; Anderson & Krathwohl, 2020).

Three Categories of Life Skills in Science Teaching

Life Skills for Living with Oneself in Science Education

Life skills that support learners in understanding and managing themselves are foundational for personal growth and academic resilience. In science education, these intrapersonal skills are particularly valuable as learners often encounter complex content, uncertainty in experimentation, and the need for reflective thinking. These skills help students develop the capacity to stay motivated, adapt to setbacks, and take ownership of their learning. According to the World Health Organisation (WHO, 2025b), such life skills enhance emotional regulation, personal agency, and persistence in learning environments, traits essential for effective engagement in science.

Self-awareness is the ability to recognise one's emotions, thoughts, and behaviours. In science classrooms, this skill enables learners to reflect on their reactions to challenging tasks. For example, a student may acknowledge feeling anxious before performing a chemistry experiment and consciously apply breathing techniques or seek peer support to manage that anxiety. This metacognitive approach helps learners build confidence and enhances their ability to stay focused under pressure (OECD, 2021a; Zimmerman, 2015).

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Self-esteem plays a crucial role in shaping how learners perceive their competence in science. When students successfully complete tasks such as building a working model of the human circulatory system or accurately interpreting experimental results, they experience a boost in confidence and are more likely to take on new scientific challenges. Research shows that positive reinforcement through success in hands-on science activities supports long-term academic motivation and self-worth (Deci & Ryan, 2017; Trilling & Fadel, 2018).

Coping with emotions and stress is another key life skill that fosters resilience. Scientific inquiry often involves trial and error, and not all experiments go as planned. Learners who can manage disappointment and frustration when an experiment fails are more likely to persist by seeking alternative strategies or revisiting their hypotheses. This ability to emotionally regulate in the face of failure builds perseverance and promotes a growth mindset, qualities that are critical for long-term success in science and beyond (Dweck, 2016 & WHO, 2025).

Together, these life skills, self-awareness, self-esteem, and coping with emotions and stress, are essential for nurturing scientifically literate individuals who can think independently, reflect critically, and remain resilient in the face of academic and life challenges.

Skills of Living with Others (Interpersonal Skills)

Skills of living with others, also referred to as interpersonal skills, are the abilities that enable individuals to interact harmoniously and effectively with others in a variety of social settings. According to Delors et al. (1996), these are essential life skills that allow learners to live together peacefully, understand one another, and build social cohesion. In the context of science education, interpersonal skills play a vital role as learners often work in teams to conduct investigations, discuss scientific ideas, and engage in problem-solving tasks that mirror real-life scenarios.

Communication is one of the most critical interpersonal skills in science learning. It enables learners to express their ideas clearly, listen to others, and exchange scientific information effectively. For example, during a group presentation on pollution, students might explain the causes and effects of acid rain using appropriate scientific terminology and visual aids. This form of communication not only demonstrates their understanding but also enhances peer learning. Osborne and Dillon (2017) emphasise that science education must promote communicative competence as it is fundamental to scientific literacy and engagement.

Empathy and respect are essential when learners are required to consider diverse opinions, especially in controversial or ethically sensitive scientific discussions. During a classroom debate on the ethics of animal testing, learners are expected to present their arguments respectfully while listening attentively to opposing viewpoints. This promotes a culture of tolerance and inclusive dialogue. According to the OECD (2020), empathy and respect are central to global competency, enabling learners to navigate diversity and engage in respectful collaboration across cultures.

Teamwork and cooperation are foundational in scientific activities that demand group effort and shared responsibility. A typical example is when learners collaboratively design a compost pit as part of an environmental science project. Each group member may take on specific roles, such as researching composting methods, gathering materials, or constructing the pit. Through such cooperation, students build trust, enhance social bonds, and develop a sense of collective achievement. As UNESCO (2021a) notes, cooperative learning nurtures democratic values and supports inclusive education.

Conflict resolution is another crucial interpersonal skill that arises naturally in science learning, particularly in group tasks where differing opinions and approaches may lead to tension. When

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disagreements occur during a lab experiment or group discussion, learners must resolve them peacefully by negotiating and finding common ground. The World Bank (2022) argues that conflict resolution skills are essential in fostering positive relationships and maintaining productive learning environments.

Leadership and negotiation are developed when learners take on roles that require initiative and coordination. For instance, a student leading a group in a citizen science project on local water quality may need to guide peers, allocate tasks, and mediate differences of opinion. These experiences promote confidence and the ability to influence group outcomes positively. The International Bureau of Education (IBE, 2023) highlights that leadership and negotiations are vital for preparing learners to contribute to democratic societies and sustainable development efforts.

UNESCO (2025b) reaffirms that fostering interpersonal skills in science education promotes inclusivity, equity, and collaborative problem-solving. These skills not only enrich the science learning experience but also prepare learners to participate actively and responsibly in society. As Delors et al. (1996) originally proposed, learning to live together remains a cornerstone of education in the 21st century, especially in disciplines like science that are central to addressing global challenges.

Skills of Making Effective Decisions

Skills of making effective decisions, often categorised as cognitive and critical thinking skills, refer to the abilities that enable learners to reason logically, think independently, solve problems, and evaluate alternatives before making informed choices. These skills are foundational in science education, where learners are encouraged to question, investigate, analyse, and apply knowledge to real-world contexts. According to WHO (2016), such life skills are essential for enabling individuals to cope with everyday demands while making reasoned and ethical decisions. In science classrooms, they empower learners not only to grasp scientific concepts but also to use scientific thinking to address personal, societal, and environmental issues.

Critical thinking is a core skill that allows learners to analyse arguments, assess evidence, and draw reasoned conclusions. In science teaching, students may be tasked with evaluating the safety and ethical implications of genetically modified foods. This involves comparing multiple scientific sources, assessing the reliability of the information, and making conclusions based on objective evidence. As highlighted by Facione (2016), cultivating critical thinking is essential for developing independent thinkers who can engage with complex scientific and ethical issues responsibly.

Problem-solving in science involves identifying challenges, investigating causes, and developing practical, evidence-based solutions. For example, students might analyse data from school waste audits to propose strategies for reducing plastic consumption. This process not only enhances their analytical abilities but also nurtures a sense of agency and responsibility. UNESCO (2021b) emphasises that science education should promote learners' ability to solve problems collaboratively and creatively, especially when addressing local and global environmental challenges.

Decision-making requires learners to weigh the pros and cons of different options and make choices based on logic, feasibility, and values. In science lessons, students may decide between two science fair projects by considering available materials, time constraints, and the relevance of each topic to pressing environmental issues. The OECD (2025) points out that these decision-making competencies prepare students to participate actively in science-related discussions and make responsible choices that impact their communities and the environment.

Creative thinking also plays a critical role in effective decision-making. Learners are encouraged

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to think beyond conventional solutions when designing experiments or proposing innovations. For instance, when exploring renewable energy sources, students might creatively design prototypes of solar cookers or wind turbines using recycled materials. According to Partnership for 21st Century Learning (P21, 2019), creativity in science education supports innovation and prepares learners for a rapidly evolving world.

Self-awareness and reflection, while often associated with personal development, are deeply intertwined with cognitive decision-making. Learners who reflect on their learning processes, strengths, and areas for growth are better able to make informed academic and personal choices. For example, after receiving feedback on a lab report, a student may set specific goals to improve data analysis in future work. As noted by the World Bank (2022), reflection and metacognition enhance learners' ability to adapt and make decisions that align with their personal values and goals.

Goal setting and planning are additional decision-making skills embedded in science learning. When working on long-term science projects, students must plan their timelines, set realistic objectives, and monitor their progress. These planning skills foster persistence and accountability, contributing to long-term academic success and life readiness. The International Bureau of Education (IBE, 2023) emphasises the role of structured decision-making processes in building student autonomy and competence.

In summary, life skills associated with cognitive and critical thinking are indispensable in science education. They equip learners with the intellectual tools needed to navigate complexity, solve problems creatively, and make ethical decisions grounded in evidence. As UNESCO (2025) asserts, nurturing these skills through science contributes not only to academic excellence but also to the development of responsible, reflective, and empowered citizens capable of contributing to sustainable development.

Values and Indicators in Life Skills Development through Science Education

In science education, values refer to the principles or standards that guide learner behaviour, shape attitudes, and inform ethical decision-making. These values underpin life skills such as critical thinking, emotional intelligence, interpersonal communication, and problem-solving (UNESCO, 2022). Values are essential in nurturing responsible citizens who can apply scientific knowledge for personal and societal well-being.

On the other hand, indicators are observable behaviours, actions, or responses that demonstrate the extent to which a particular value or life skill has been acquired or applied. Indicators provide measurable signs of learning progress and are vital for assessment and evaluation (WHO, 2019).

Science classrooms present rich opportunities to promote both values and life skills. For instance, while conducting experiments, learners can develop honesty (value) by accurately recording results (indicator), or teamwork (value) through active participation in group tasks (indicator).

Table 1: Selected Life Skills, Values, and Indicators in Science Education

Life Skill	Associated Value	Indicator (Observable Behaviour)
Critical Thinking	Integrity	Learner accurately records and reports experimental findings (WHO, 2019).
Problem Solving	Responsibility	The learner takes initiative to identify and solve science-related challenges.
Communication	Respect	Learner listens actively and responds politely during group discussions.

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Life Skill	Associated Value	Indicator (Observable Behaviour)
Teamwork	Cooperation	Learner shares materials and supports peers during practical science tasks.
Decision Making	Accountability	Learner justifies choices made during project work with evidence and reasoning.
Emotional Self-Regulation	Patience	Learner remains calm when an experiment fails and tries again systematically.
Empathy	Compassion	Learner supports peers emotionally during group science presentations.
Creativity	Innovation	Learner designs new models or ideas for solving environmental problems.
Self-Awareness	Honesty	Learner reflects truthfully about strengths and areas for improvement.
Conflict Resolution	Tolerance	Learner mediates fairly when disagreements arise during group experiments.
Leadership	Service	The learner takes the lead in organising science fairs or environmental campaigns.
Time Management	Commitment	Learner submits science assignments and projects on time.
Negotiation	Fairness	Learner agrees on fair roles in group science work with mutual understanding.
Self-Confidence	Courage	Learner volunteers to demonstrate science experiments before the class.
Environmental Stewardship	Responsibility	Learner participates in recycling or conservation science activities.

Source: *Secondary Primary Data*

Incorporating values through life skills in science classrooms enhances the moral and ethical dimension of learning. For example**,** integrity, as demonstrated by truthful data recording, teaches learners the importance of honesty in scientific inquiry (Bybee, 2015b). Similarly, accountability is cultivated when learners explain their decisions during science projects, reinforcing evidence-based reasoning critical aspect of scientific thinking (OECD, 2018).

Respect and cooperation are integral when learners engage in group discussions or laboratory work. These values are essential in building a harmonious learning environment and preparing learners for future collaborative workspaces (UNESCO, 2020a). Moreover, by guiding learners to be innovative in solving real-life problems such as designing water purification models or creating composting bins, teachers promote both creativity and environmental responsibility (Kirabo, 2025).

Additionally, life skills such as conflict resolution and emotional regulation are nurtured through collaborative inquiry. For instance, during disagreements in group experiments, learners who practice tolerance and fair mediation demonstrate maturity and empathy traits highly valued in 21st-century citizenship (UNICEF, 2021a).

Ultimately, the integration of values and indicators into science teaching provides a structured way for educators to assess both the cognitive and affective development of learners, fostering well-rounded individuals who are capable of applying science responsibly and ethically.

Benefits of Effective Communication in Science Classrooms

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Effective communication is an essential pillar in science teaching and learning. In a subject that often deals with abstract concepts, unfamiliar terminology, and practical applications, the ability of the teacher to communicate clearly and responsively has a direct impact on learners' understanding, participation, and achievement. This section discusses fifteen key benefits of effective communication in the science classroom.

To begin with, effective communication enhances conceptual understanding by making abstract and complex scientific ideas more relatable. For instance, when a teacher uses analogies such as comparing electrical circuits to water flowing through pipes, learners better grasp the underlying principles. Bybee (2015a) stresses that scientific ideas become meaningful when delivered through interactive and engaging communication strategies.

Another significant benefit is that it promotes active participation. Learners are more likely to ask questions, give opinions, and contribute to discussions when the classroom environment is welcoming and communicative. In science lessons, allowing pupils to relate classroom content to real-world experiences, like discussing how plastic waste affects their local environment, makes learning more relevant and participatory (UNESCO, 2020b).

Effective communication also builds learners' confidence and expression skills. When learners are encouraged to explain their thinking or present group findings, their self-esteem improves. For example, explaining an experiment on water filtration builds both content knowledge and public speaking abilities. OECD (2018) found that such positive communication increases learner motivation and confidence.

In addition, communication encourages collaboration among peers. During group science tasks like building a model of the solar system or conducting experiments, learners must negotiate roles, share ideas, and listen to one another. These collaborative experiences promote teamwork and interpersonal communication skills (UNICEF, 2021b).

Moreover, strong communication strengthens teacher-learner relationships, which is foundational for effective learning. A teacher who listens actively and gives constructive feedback creates a safe space for learners to express themselves. Mutua and Namukasa (2019a) argue that trust and respect flourish in classrooms where communication is empathetic and reciprocal.

Furthermore, clear communication reduces scientific misconceptions and learning errors. Misunderstandings, such as confusing mass with weight, can be clarified through targeted explanations and visual demonstrations. Miller and Veith (2017a) highlight that science misconceptions are often the result of poor or ambiguous communication.

Assessment also benefits from effective communication. Through feedback, questioning, and interactive discussions, teachers can assess what learners understand and adapt instruction accordingly. Black and Wiliam (2018a) emphasise that formative assessment becomes more meaningful when supported by real-time classroom dialogue and feedback.

Effective communication also supports inclusive learning. Science classrooms often include learners with diverse abilities. A teacher who uses multiple modes of communication, like verbal, visual, and hands-on, ensures that all learners, including those with learning difficulties, can participate meaningfully (UNESCO, 2021b).

In addition, communication promotes critical thinking. When learners are asked to justify their reasoning, such as proposing why certain materials conduct electricity while others do not. Another advantage is that communication enhances problem-solving skills. Science often involves investigating phenomena and experimenting, where

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learners must articulate hypotheses, observe results, and discuss conclusions. Through effective communication, teachers guide learners to break down complex problems into manageable steps, fostering systematic reasoning (Nsibirwa & Mugisha, 2020).

Effective communication also facilitates the integration of technology and multimedia in science lessons. When teachers explain how to use digital tools such as simulation software for chemical reactions or data collection apps, learners are better able to engage with modern scientific inquiry methods (Kahenya, 2019).

Additionally, communication fosters cultural relevance and contextualisation of science content. By encouraging learners to share local knowledge and experiences related to science, teachers make learning more meaningful (Mutua & Namukasa, 2019b). For example, discussing indigenous farming practices alongside soil science enhances both scientific literacy and cultural appreciation (Kigongo, 2021). Communication further motivates learners by making science enjoyable and accessible. Enthusiastic storytelling, questioning, and humour can capture learners' interest and reduce anxiety about difficult topics, boosting engagement and persistence (Chand & Saini, 2017).

Moreover, effective communication prepares learners for future academic and career pathways by developing their ability to articulate scientific ideas clearly. Whether in writing lab reports, presenting findings, or participating in debates, strong communication skills are vital for scientific careers (UNICEF, 2019).

Finally, communication supports ethical understanding and responsible behaviour in science. Teachers who openly discuss the implications of scientific discoveries, such as environmental stewardship or the responsible use of technology, help learners develop values that guide their future actions (Muwanga-Zake, 2022).

In summary, effective communication in science classrooms plays a multifaceted role by enhancing understanding, participation, collaboration, critical thinking, and motivation among learners. It also supports inclusivity, assessment, and ethical awareness, all of which contribute to holistic science education. Science teachers who prioritise and develop strong communication strategies thus equip learners not only with knowledge but also with essential life skills for academic and social success.

Strategies for Developing Life Skills among Learners

Developing life skills among learners is a crucial component of holistic education. In the context of science teaching, life skills such as critical thinking, effective communication, emotional regulation, and responsible decision-making can be cultivated through intentional classroom strategies. The following are 15 approaches that science teachers can use to integrate life skills into daily instruction.

One effective strategy is Problem-Based Learning (PBL). This approach allows learners to engage with real-world challenges, enhancing critical thinking and collaborative problem-solving (OED, 2021b). For instance, learners might investigate local water pollution and propose scientific solutions, thereby practising decision-making and creativity (Bellanca, 2015).

Group work and peer collaboration also offer opportunities for learners to develop teamwork, communication, and leadership. In a science experiment, dividing roles such as recorder, presenter, and materials manager teaches cooperation and builds confidence. As OECD (2018) asserts, structured group activities prepare learners to navigate complex social dynamics.

Reflective journaling supports the development of self-awareness and emotional intelligence. After conducting a science activity, learners can reflect on what they learned, the challenges they faced, and how they felt. Dweck (2017) emphasises that

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reflective practices foster a growth mindset, enhancing learners' resilience and adaptability.

Another method is role-playing and simulation. For example, learners may take on the roles of scientists, community leaders, or environmental activists during discussions about deforestation. This encourages empathy and public speaking skills. According to UNESCO (2022), experiential learning helps students navigate real-life scenarios with emotional and social maturity.

Goal-setting and time management are cultivated when learners undertake long-term science projects or prepare for a science fair. Teachers guide learners to break tasks into manageable steps and monitor progress, promoting discipline and organisational skills (WHO, 2019).

In today's digital world, integrating digital literacy into science lessons is vital. Assignments involving online research or creating digital presentations teach learners to evaluate information critically and behave responsibly online. Kirabo (2025) found that digital integration enhanced learners' analytical and ethical reasoning skills in Ugandan classrooms.

Science teachers can also provide leadership opportunities by appointing learners as group leaders, science club heads, or experiment coordinators. Such roles foster initiative, accountability, and planning. Njiru (2021) observed that learners entrusted with leadership roles develop stronger decision-making and interpersonal skills.

Conflict resolution and mediation training can be introduced when learners disagree during group tasks. Teachers can use these situations to coach learners on how to express opinions calmly and find a compromise. UNICEF (2020) supports peer mediation programs as effective in cultivating empathy and conflict management.

Engaging learners in community-based projects, such as tree planting or school garden initiatives, links science learning with civic responsibility. These activities build collaboration and environmental stewardship. The Ministry of Education and Sports Uganda (2023) recommends service learning to strengthen social responsibility and teamwork.

Using inquiry-based learning, teachers can empower learners to ask scientific questions and explore them through investigation. This promotes curiosity, analytical thinking, and perseverance. Bybee (2015a) argues that inquiry fosters essential life skills, including logical reasoning and evidence-based decision-making.

Emotional literacy can be enhanced by explicitly teaching learners to name and manage emotions, especially when facing setbacks in science tasks. For example, discussing frustration after a failed experiment helps build resilience. CASEL (2020) supports social-emotional learning as critical for academic and personal success.

Life skills development is stronger when parents are involved. Teachers can encourage family science activities or home-based reflections, reinforcing life skills beyond the classroom. UNESCO (2020a) highlights that parental involvement significantly boosts learners' responsibility and communication skills.

Storytelling and narrative-based teaching also serve as effective tools. Sharing biographies of scientists who overcame adversity, for example, fosters perseverance and moral reasoning. Achieng and Mulumba (2019) found storytelling to be a culturally relevant method for character development in Ugandan schools.

Participation in co-curricular activities like science clubs, drama, or sports provides learners with chances to practice creativity, cooperation, and stress management. WHO (2019) emphasises that such activities contribute to balanced development and improved emotional health.

Finally, life skills must be integrated into the curriculum, rather than treated as separate from academic subjects. In science, this could involve

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lessons on sustainable living, personal hygiene, or nutrition topics that naturally lend themselves to discussions about values and decision-making (UNESCO, 2022b).

In summary, life skills development requires a deliberate blend of pedagogical strategies. Through inquiry, collaboration, leadership, emotional support, and experiential learning, science teachers can cultivate learners who are not only academically competent but also equipped with the skills needed to thrive in life and society.

The Role of Tutors/Lecturers in Developing Life Skills among Science Education Student Teachers

In the Ugandan teacher training context, tutors and lecturers hold a pivotal role in equipping science education student teachers with life skills that go beyond academic proficiency. As facilitators of both knowledge and character, they help future educators acquire interpersonal, cognitive, and intrapersonal competencies that are essential for effective science teaching and lifelong learning. Through deliberate instructional practices, mentorship, and modelling, tutors play multiple roles in promoting life skills development.

Role Modeling

Tutors serve as the first and most consistent role models for student teachers. By demonstrating ethical behaviour, professionalism, and strong interpersonal communication in their teaching, they help student teachers internalise these values. According to Bandura (2006), social learning occurs through observation; hence, when lecturers model collaboration, critical thinking, and empathy, student teachers are more likely to emulate such behaviours.

Integrating Life Skills into Pedagogy

Tutors must intentionally integrate life skills education into science instruction. This includes designing lessons that not only convey scientific knowledge but also incorporate skills such as decision-making, teamwork, and critical thinking. WHO (2016) emphasises that life skills should be taught both explicitly and through integration into subject content, a principle that holds true in Uganda's competence-based curriculum (NCDC, 2020). Incorporating life skills in teachers' planning is therefore commendable for opportunities to be created for life skills development, which has a great influence on their retention and understanding of science concepts.

Facilitating Inquiry-Based Learning

Inquiry-based methods in science teaching promote problem-solving, decision-making, and creativity. Tutors who facilitate these methods create opportunities for student teachers to engage in investigative learning. Harlen (2016) argues that inquiry fosters not only scientific understanding but also personal and social skills critical for classroom leadership. It is therefore vital that science tutors design activities that demand learners to learn through inquiry. This provides opportunities for students to interact with others and the wider community.

Encouraging Reflective Practice

According to Schön (2017), reflection is central to professional learning and continuous improvement. Tutors should therefore cultivate a habit of reflection among student teachers by providing them with the relevant guidance on reflective practice. By guiding them through journals, self-assessment, and peer reviews, tutors help future educators critically assess their teaching and personal growth.

Promoting Collaborative Learning

In line with Vygotsky's (1978) social constructivist theory, collaborative learning allows student teachers to develop teamwork, empathy, and communication. Ugandan tutors can use group projects and co-teaching opportunities to build these interpersonal skills, as supported by Ainomugisha (2019), who found that collaborative models

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enhance peer support in teacher training colleges. This, therefore, means that the tutor should plan students' assessment tasks so that priority is given to problem-solving tasks that require students to collaborate.

Supporting Student-Led Projects

Student-led initiatives, such as science clubs, community outreach, and school gardening, are powerful platforms for applying life skills. Tutors who support such initiatives nurture leadership, planning, and social responsibility. According to Tumusiime et al. (2020), student-led science projects in Uganda have been instrumental in fostering confidence and community engagement. Efforts should therefore be made by tutors to embrace the project method of teaching so as to support students in acquiring the relevant life skills.

Assessing Life Skills Formatively

Lecturers play a key role in designing assessments that evaluate not just cognitive achievement but also life skills such as creativity, collaboration, and ethical reasoning. Black and Wiliam (2018b) emphasise formative assessment as a tool for guiding students' holistic growth, a practice encouraged in Uganda's teacher education framework (MoES, 2017; Millers &Veith, 2017b). Nonetheless, some tutors may not be conversant with this knowledge on authentic assessment that requires continuous professional development for efficiency and effectiveness.

Mentoring and Counselling

Tutors provide mentorship that extends beyond academics into social and emotional development. By offering guidance on time management, career choices, and conflict resolution, they help shape well-rounded educators. Kajubi (2021) asserts that effective mentoring reduces anxiety and promotes professional confidence among Ugandan student teachers. Peer mentoring programs should be embraced in teacher training so that opportunities are provided for experienced and knowledgeable students to be paired with the novice one. This, in the long run, will promote the lateral transfer of learning.

Encouraging Civic Engagement and Sustainability

Science education is uniquely positioned to address sustainability and environmental issues. Tutors can foster responsible citizenship by linking science content to real-world issues such as climate change and waste management. UNESCO (2021b) advocates for education that builds the capacity to act for sustainable development, a goal aligned with Uganda's Vision 2040 (NDPIII, 2020). Tutors should always use a practical methodology that enables students to generate knowledge using their day-to-day experiences through curriculum localisation.

Creating Inclusive Learning Environments

Tutors must be intentional about creating environments that support equity and inclusion. This includes using gender-sensitive language, valuing diverse perspectives, and accommodating learners with special needs. Inclusive education enhances empathy and social responsibility, as confirmed by Nakabugo et al. (2022) in their work on inclusive practices in Ugandan teacher colleges. This can be achieved through the utilisation of social justice principles.

Encouraging Ethical Reasoning in Scientific Inquiry

Resnik (2018) clarifies that ethics education in science nurtures integrity and responsible innovation. In teaching science, tutors should address the ethical dimensions of scientific developments. This can be achieved by having discussions around biotechnology, environmental ethics, and indigenous knowledge, which can help student teachers develop ethical reasoning, which is a vital life skill.

Embedding ICT Skills in Teaching

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In an increasingly digital world, integrating ICT into science pedagogy supports problem-solving, creativity, and adaptability. Tutors must equip student teachers with the digital literacy required to teach and learn effectively. The Uganda Communications Commission (UCC, 2019) stresses that ICT integration enhances learning and prepares teachers for the digital economy. However, efforts should be taken by the administrators to extend their will towards enforcing the use of ICT in teaching and learning science education. Most importantly, steps should be taken to retrain and train tutors on ICT use, as the majority of them have little or no skill at all.

Fostering Self-Esteem and Resilience

Tutors can help build student teachers' confidence by recognising their efforts, encouraging risk-taking, and supporting them through setbacks. Lecturer's words and attitude can significantly affect learners' self-perception. According to Goleman (2018), emotional intelligence, including self-awareness and resilience, is vital in managing classroom dynamics and personal well-being. This can be achieved through assessment feedback platforms where students can be rewarded for their hard work and input.

Building Critical Consciousness

Freire (2018) highlights the value of critical pedagogy in empowering learners to transform society, an approach increasingly advocated in African teacher education (Muwanga-Zake, 2017). Tutors should help student teachers examine social injustices and inequalities in science education. This includes interrogating whose knowledge is taught, how it is assessed, and whose voices are excluded.

Engaging with Community-Based Learning

By connecting science teaching with community issues such as sanitation, disease control, or agricultural productivity, tutors guide student teachers in applying life skills in meaningful contexts. Kolb's (2015) experiential learning theory supports this approach, and in Uganda, community-based practicums are already used to bridge theory and practice (Kyambogo University, 2019). Alternatively, opportunities can be created where resource persons within the community are utilised to promote science teaching and learning.

From the researchers' experiences in Ugandan teacher training institutions, it is clear that when tutors deliberately foster life skills, student teachers emerge not just as science educators but as holistic, ethical, and community-conscious professionals. However, for these roles to be fully realised, there is a need for continuous professional development of tutors themselves, improved resource availability, and institutional support for life skills integration in science education.

CONCLUSION

This paper has established a comprehensive framework illustrating how life skills are central to effective science education. From defining what life skills entail to exploring their categories, underlying values, benefits, and teaching strategies, the framework underscores the indispensable role of teachers in fostering these skills. Science education, when infused with life skills, transitions from rote learning to a transformative process that equips learners with essential competencies for life and work in the 21st century.

Implications for Science Education, Teaching, and Teacher Training

In the Ugandan teacher education context, the implications are profound. First, science teacher training programs must be restructured to intentionally incorporate life skills development as an outcome of science teaching. Tutors should be equipped not only with content knowledge but also with pedagogical approaches that nurture intrapersonal, interpersonal, and critical thinking skills.

Secondly, teacher education institutions must model inclusive, collaborative, and inquiry-based learning

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environments that student teachers can emulate in their future classrooms. Assessment practices must also evolve to include both formative and summative evaluation of life skills.

Furthermore, policies and curriculum guidelines from bodies such as the Ministry of Education and Sports (MoES), National Curriculum Development Centre (NCDC), and teacher education colleges must support the integration of life skills into science instruction. This requires investment in teacher capacity building, instructional materials, and monitoring frameworks that evaluate the impact of life skills on student learning outcomes.

Ultimately, the development of life skills among science student teachers is not just an educational priority, it is a national imperative. It prepares future educators to contribute meaningfully to Uganda's development agenda, equips learners with knowledge and skills to navigate complex societal challenges, and fosters a science-literate, skilled, and values-driven citizenship.

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