TEACHING AND LEARNING STRATEGIES WITH EVOLVING TECHNOLOGIES

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Protocol

Introduction and Research Purpose

The popular maxim goes that “Necessity is the mother of invention,” meaning “The primary driving force for most new inventions is a need.” If need is the primary driving force for inventions, the question is What are the needs behind the 21st Century evolving technologies that are meant to meet these needs? The answer is not far-fetched but the scope needs to be narrowed to fulfil a twofold purpose namely: (1) To examine the common teaching and learning strategies that can be supported with evolving technologies, and (2) To identify the likely challenges that could arise in the attempt in implementing teaching and learning needs with evolving technologies and proffer solutions. Achieving these objectives also requires that we do some operational definition of key concepts. This is what is considered next.

Operational Definition of Key Concepts

In this discussion, I argue that technology is both an avenue and a potent means of solving problems. But what have the experts said technology is? From the common usage of the term, which this discussion adopts, technology loosely includes any manufactured object, machinery and the applied scientific knowledge to solve issues of life. Technology is the ‘knowhow’ knowledge of how to make things that would otherwise not exist.(Agar, 2019). Glubler's (2003) maintains that technology includes manufactured hardware and artifacts whose purpose is either to enhance human capabilities (e.g., with a hammer you can apply a stronger force to an

object) or to enable humans to perform tasks they could not perform otherwise (e.g. with an aircraft you can transport large amounts of goods and people to far destinations). These definitions and examples, which are adequate for this discussion suggest that technology is a human creation as different from natural creation.

Technology evolution

No one is to doubt the reality that technology is evolving and will continue to evolve with a sense of urgency to provide quick solutions to the ever-increasing man-made and natural challenges. If we have to look back, we can confirm that the 18th Century technological inventions are not necessarily the same as the 19lh Century, 20th Century or 21st Century technologies. We thus align our view with that of Rosenbloom (2007) who argues that technology evolves in two distinct ways: through gradual, incremental modifications in existing products and processes, and through discontinuous leaps in technology caused by the introduction of entirely revolutionary new innovations. To elaborate more, the 20th Century was generally regarded as the American Century due to the dominance of America in industrialization and transfer of technological leadership from Britain and other European nations to America in the course of World War I and World War II. This period recorded notable inventions such as automobiles, airplanes, the radio, television, computers and transistors, which gave birth to the digital age (Nalinaksh, 2021). For the 21st Century, the needs of humanity changed radically, with greater emphasis placed on knowledge and information management. Sometimes called the 'knowledge age' (Erdem, 2019), or 'information age' (Udu and Nwaokike, 2023),the 21st Century is most known for the ubiquitous use of technology (Erdem, 2019) in the form of e-commerce, e-governance, e-marketing, .e-teaching, e-learning etc. Jerald (2009) describes the 21st Century as an era of automation, globalization, and workplace change.

By automation, Jerald means the use of computers and computer-driven machinery to replace human labour. In the 21st Century, computers are believed to work better, faster, and more cheaply than humans (Jerald, 2009). The second major feature of the 21st Century is globalisation. Globalisation refers to the growing interdependence of the world's economies, cultures, and populations, brought about by cross-border trade in goods and services, technology, and flows of investment, people, and information (Kolb, 2018).

The needs of the 21st Century come in the form of the 17 Sustainable Development Goals (SDGs) and 21st Century Skills. Joynes, Rossignoli, and Fenyiwa Amonoo-Kuofi (2019) outlined these skills in five broad categories as:

1. Communication skills, including language and presentation of ideas.
2. Collaborative skills, including management of group activities and social interaction.
3. Individual learning approaches, including critical thinking, metacognition and new skills acquisition.
4. Individual autonomy, including flexibility, adaptability and entrepreneurship.
5. ICT and digital literacy, including use of technology as tools for learning, communication and collaboration.

The United Nations (UN, 2018) recognize and support the use of new technologies for the attainment of SDGs. According to the UN:

> New and rapidly developing technologies such as artificial intelligence, biotechnology, material sciences and robotics hold incredible promise for the advancement of human welfare. They also hold the potential to generate more inequality and more violence (p.4)

The UN further states:

> Today's rapid digital and technological transformations have brought us to another critical moment. They inspire hope of immense benefits that can elevate the human condition everywhere. We can see a future

> transformed by learning machines and artificial intelligence, edited genomes, autonomous cars, stateless currencies and private space travel. These new technologies hold incredible promise for human welfare. They hint at a future of individualized medicine and reduced pandemics, of globally disseminated knowledge and sustainable climate management, accelerated financial inclusion and entrepreneurship, and even asteroid mining. They offer us powerful new ways to achieve our shared commitments to each and every one of the Sustainable Development Goals (SDGs). (p8).

Common teaching and learning strategies that can be supported with evolving technologies

So far, the discussion has been general. The discussion is now narrowed to how new technologies can help teachers actualize the dream of turning out graduates who can compete favourably with their counterparts in the job markets.

Education and technology go hand and in hand and the benefits of deploying technology to support teaching and learning are overwhelming. A few examples can be given:

(a) **Use of cell phones in classes:** Although once forbidden, cell phones form an integral part of today's classrooms globally. Selina and Thilagam (2020) testify that:

> recent evolution in technology has allowed teachers to learn and collect knowledge from mobile phones and .other multimedia equipment. In addition, internet and other media networks allow students from all over the world to communicate and transfer ideas. Students should read better to learn more about the reality and the philosophy, and teachers must help students use the best knowledge to fulfil their academic outcomes and to progress towards achievement.(p. 4842)

(b) **Hybrid instruction:** Even if the part of the course demands the physical presence of the teacher, another portion can be taught online without losing the quality of instruction.

(c) **Virtual learning environment:** Digital environments allow for communication between students and teachers as well as sharing of information.

(d) **Smart Interactive Board:** An interactive board is a 21st Century classroom tool that allows images from a computer screen to be displayed onto a classroom board using a digital projector. Highlighting its benefits, Udu (2021) argues that it encourages collaborative learning and effective communication. It also accommodates students with different learning styles and make the classroom an enjoyable experience for even reticent students. Udu (2021) further maintains that in teacher training programmes, the interactive board is a professional teacher's companion for microteaching preparation and simulation. Above all, the interactive board is a tool that can be used with all the subjects in the curriculum.

(e) **Micro-learning:** Instruction in small doses for topics that require fast and efficient training. An example might be a short video lecture.

(f) **Personalized learning:** The process of adapting education paths according to each students' needs, making their experience much better.

Common Teaching and Learning Strategies that Support Evolving Technologies

Decision making regarding choice of a teaching strategy could be as a result of many factors-the nature of the topic to be taught, prior knowledge of learners, age of learners, teacher's expertise, etc. However, what is known is that the following teaching and learning strategies are amenable to new technologies, and are therefore, recommended for use.

1. **Flipped Classroom Procedure:** According to Hamdan, McKnight, McKnight and Arfstrom, (2014), the concept of flipped classroom rests on four pillars and comes from the acronyms F-L-I-P, which stands for Flexible Environment, Learning Culture Shift, Intentional content, and Professional Educators. A flexible learning environment, which is the first phase represents adaptability to learning styles as well as teacher accommodation in the classroom. An effective teacher manipulates the classroom by providing learning activities with the best outcomes. Flexibility also applies to assessment and evaluation tool used to evaluate students' learning. There are two types of flipped classroom designs. These are student-led and instructor-led models. In a flipped classroom, the traditional lecture-style teaching gives way for pre-recorded video lectures or online instructional materials. Students can be allowed to access these resources at their own pace before coming to class. Classroom time is then dedicated to interactive activities, discussion, and collaborative learning. An effective flipped classroom recognizes the principle of providing learners the opportunity to gain First exposure prior to the class; providing an incentive for them to prepare for the class and a mechanism to assess their understanding. Flipped classrooms has both advantages and disadvantages! Kraml (2024) lists benefits to include flexibility of class scheduling, personalized learning experiences and increased interaction. Demerits include learning style mismatches, difficulties in measuring engagement and providing timely feedback.

2. **Gamification:** This strategy involves incorporating game elements and mechanics into the learning process to engage and motivate students. This can be done through online quizzes, interactive simulations, and educational games. The use of gamification platforms and tools enables teachers to create interactive and immersive learning experiences that promote active participation and knowledge retention. There are two types of gamification-structural and content gamification. Gamification in

education is a developing approach to incorporating game design elements, gaming techniques, and thinking strategies in educational environments to boost learners' motivation and engagement. Considering the growing popularity of the concept and yet mixed opinions of its usage in educational contexts, it is pertinent to shed a more realistic light on what gamification in education is. According to Savonin and Lyzanets (2022), the idea isn't new, but the term “gamification” did not enter mainstream vocabulary until in 2010. However, many have considered it inefficient as a tool. Some consider gamification to be only a tool for reward or punishment, and some introduced the idea that games in education should serve as an external tool to motivate learners. It is also alleged that games create unfair competition. Although these criticisms deserve attention, this may be due to other factors like the bad design of games or irrelevant use. The common elements of educational games include:

- Onboarding
- Game levels
- Badges and point-based rewards
- Leader boards
- Timers
- Signposts and hints
- Progress bar or a limited number of steps
- Community interactions
- Story plot
- Theme
- Non-player characters and a player character
- Mystery boxes or other surprising elements

3. **Personalized Learning:** This refers to instruction in which the pace of learning and the instructional approach are optimized for the needs of the learner. Learning objectives, instructional approaches, and instructional

content (and its sequencing) may all vary based on learner needs. Evolving technologies allow for personalized learning experiences tailored to the individual needs and preferences of students. Adaptive learning platforms and intelligent tutoring systems use algorithms and data analytics to provide customized learning paths, feedbacks, and resources to students. These technologies enable teachers to differentiate instruction and address each student's unique learning gaps and strengths. In personalized learning, each student gets a learning plan based on how they learn, what they know, and what their skills and interests are. It is the opposite of the one-size-fits-all approach used in most schools. It is to be stressed that personalized learning leans on four components viz student choice, student engagement, flexible learning environment, and personal learning paths. As schools design personalized learning classrooms, the following three elements are commonly found at the core of the design work: learner profiles, customized learning paths, and proficiency based progress. Personalized learning involves three stages. Stage one is teacher-centred with learner voice and choice. Stage two is learner-centred where teachers and learners co-design learning. Stage three is when learners design and drive their own learning. One good thing about personalized learning is that it empowers students to take charge of their education. It also nurtures self-directed learning skills by encouraging students to set goals, monitor their progress, and reflect on their achievements. Main advantages of personalized instruction includes the following:

(a) **Eliminates travel time and geographical constraints:** Online tutoring eliminates travel time for both parties. Commuting at rush hour may be dreadful. Money is saved on transportation. With no need for transportation and no time limits, students who reside in rural areas can also have access to lessons or laboratories. In effect, online courses enable students to learn from home, eliminating travel time and also without being constrained by their location.

(b) **No risk of falling ill:** As it avoids getting in contact with people on travel and in class, it prevents students from falling ill. During the COVID-19 pandemic, online learning played a major role in restricting the spread of the deadly virus.

(c) **Learning through efficient resources:** In order to ensure efficient use of resources, a teacher can share folders that contain syllabus notes, case study material, previous papers, practice questions, sample questions, a copy of the specifications, links to diagrams, articles, notes, videos, and so on. This also aids in keeping things sorted and in one location.

(d) **A relaxed learning environment:** Both students and teachers feel liberated in the online environment since they are in their comfortable places. With the freedom to study from anywhere, online students may finish courses at home, in a coffee shop, or in a library. This means that students study in a setting that fits them. It also helps students develop the habit of asking questions and voicing concerns.

(e) **More tutors to choose From:** The most important reason is that students can choose an online instructor they find suitable to make them understand the concepts. Additionally, tutors and students can connect from anywhere in the world. This implies that students may be paired with the greatest teachers.

Disadvantages may include:

(a) **Technical Flaws:** A defective computer or server downtime or unreliable internet could be impediments to effective personalized learning.

(b) **Lack of social interaction:** The possibility of social interaction may only be decreased but not completely eliminated.

(c) **Distraction:** Online tutoring may be convenient for the learner but it also allows for some forms of distractions.

(d) **Security:** Security issues in the realm of online tuition may occur and this could be a disadvantage.

4. **Collaborative Learning:** New technologies such as the internet, interactive boards and a host of other 1CT tools facilitate collaboration among students, regardless of their physical location. Online discussion boards, collaborative document editing tools, and video conferencing platforms enable students to work together on projects, share ideas, and provide feedback, to their peers. When students or colleagues work collaboratively, they ask each other questions, share ideas and give feedback to direct their own learning. These groups include study groups, project groups, problem-solving or puzzle groups, writing groups, debate or Socratic circle groups, peer editing groups, and role playing groups.

Collaborative learning allows professionals to complete projects and learn new concepts while also developing social, teamwork and communication skills. Collaborative learning can be organized lo take place online or face-to-face. Technological advancements make it easy to organize collaborative lessons. New technologies make it possible for teachers and students to share classroom information which can be in the form of documents, videos or images. Herrity (2023) lists the benefits of collaborative learning to include improving problem-solving skills, encouraging social interaction, promoting diversity, improving confidence, encouraging engagement, allowing people to have fun, developing critical thinking skills and building relationships.

5. Virtual and Augmented Reality (VR/AR): These technologies offer immense learning experiences that go beyond traditional classroom settings. Virtual reality can simulate realistic scenarios such as field trips to historical sites, medical simulations, or virtual laboratories.

Augmented reality overlays digital content onto the real world, enhancing students' understanding of abstract concepts. These technologies provide hands-on, experiential learning opportunities that enhance engagement and understanding. Adamska (2023) offers nice benefits of this method to include enhanced interactive learning, increased student engagement, improved knowledge retention, personalized learning, real world application, accessibility and inclusivity, global and cultural perspectives, gamification and motivation. In addition, it has the ability to inspire students' creativity and spark their imaginations. And this can motivate them to explore new academic interests. It also helps students struggling to understand difficult subject concepts. For example, through AR, geometry students can check out 3D geometric forms from multiple perspectives; they can rotate a shape to see it from different angles and even view it from the inside. Apart from the educational benefits, VR increases the cultural competence of learners and helps them to relate academic content to different cultural contexts.

6. **Online Assessment and Feedback:** Assessment is a crucial component of e-Learning as it provides educators and trainers with a means of evaluating students' understanding and progress. However, as e-Learning continues to grow in popularity, new challenges are emerging when it comes to assessment, particularly in terms of ensuring that assessments are effective, valid, and reliable. This discussion explores the challenges of assessment in e-Learning and provides solutions for overcoming these challenges. Online assessment tools allow teachers to design and administer quizzes, tests, and assignment electronically. Instant feedback and automated grading streamline the assessment process, providing students with immediate feedback on their performance. These tools also generate data that can help teachers identify areas of improvement and personalize instruction.

It is noticed that one of the biggest challenges of online assessment is the lack of face-to-face interaction between students and instructors. In traditional classroom settings, instructors are able to observe students' non-verbal cues and body language, which can provide valuable information about their understanding of the material. In online contact however, this type of interaction is typically limited, making it more challenging to assess accurately students' understanding. In any case, one solution to this challenge is to incorporate video conferencing into online assessments. This allows instructors to interact with students in real time and observe their nonverbal cues and body language, providing valuable information about their understanding of the material. In addition, video conferencing can provide opportunities for students to ask questions and engage in real time discussion thereby helping to ensure that they are fully engaged in the learning process. Another challenge to assessment in online contact is the lack of authenticity in assessments. In traditional classroom settings, assessments often involve hands-on activities such as laboratory work or group projects. These activities provide students with opportunities to demonstrate their understanding during real-world scenarios. In online classes however, assessments are typically limited to multiple choice questions or structured written responses, which can be less authentic and provide a limited view of the students' understanding. To tackle this problem, Pappas (2016) suggests that online assessments should be designed to reflect real-world scenarios and involve hands-on activities whenever possible. In addition, assessments could also incorporate group projects or collaborative activities thus providing students with opportunities to demonstrate understanding of taught concepts.

A third challenge associated with online assessment is ensuring the validity and reliability of assessments. In traditional classroom settings, instructors are able to observe students during assessments, making it easier to ensure that assessments are valid and reliable. Online assessments are completed independently making it more difficult to check if students are not cheating or using outside sources to complete assigned tasks. To tackle this, online

assessments should be designed to minimize opportunities for cheating and ensure validity and reliability. The testing environment could be supported with online proctoring systems that monitor during assessments. This is to ensure that students do not get assistance from outside.

Online assessments can also present limitations in terms of the types of questions that can be asked and the level of detail that can be provided. For example, certain types of questions such as essays or problem solving activities may not be easily adaptable to an online format. To address this challenge, online assessments should be designed to incorporate a variety of question types and formats, including multiple choice, short answer and open ended questions, as well as interactive simulations and games.

There is also the challenge of measuring students' engagement. In traditional classroom settings, instructors are able to observe students during classes with the view to assessing their level of engagement. In e-Learning however, it can be more challenging to assess students' engagement as students are typically working independently and are not in a physical classroom. To address this challenge, online assessments should be designed to incorporate measures of students' engagement such as quizzes and simulations. Regarding feedback, this can take the forms of oral, written, informal, formal, descriptive, evaluative, peer and self-assessment. Chappuis (2012) describes three conditions regardless of the form of feedback that needs to be in place before offering feedback. These are that students need a clear vision of the intended learning, that instructional activities need to align directly with the learning and students need to see the nexus, and that assessments need to be set up so that they can interpret the results as indicators of what they have or have not yet learned. Providing feedback means giving students an explanation of what they are doing correctly and incorrectly, with focus on what the students are doing right. It is most productive to students' learning when they are provided with an explanation as to what is accurate and inaccurate about their work. Feedback in online

learning is crucial for both users and creators. In any work or school environment, feedback is a key component as it provides a useful tool to let those involved know whether they are progressing in the right direction and in what areas they can improve. Feedback also provides positive criticism and allows to be seen what anyone can do to improve their focus and results. It brings people together and creates a healthy communication flow. It is also vital because it supports students to understand what is to be done and how to improve their performances. It also enables the teacher to see how teaching practice can be improved, and which teaching and learning strategies are more likely to be effective. It provides useful information that helps each student to address his learning gap.

7. Data Analytics and Learning Analytics: Data analytics and learning analytics are avenues for utilizing data generated from students' interactions with education platforms. Such information is essential in gaining an insight into students' learning progress and behavior. Teachers can analyse such data to identify patterns, trends, and frequency to arrive at informed instructional decisions such as what to reteach, what remedial measures to adopt and areas that need improvement. Learning analytics is the process of collecting, analyzing and interpreting data generated by learners during their e-learning journey. The main objectives of learning analytics is to identify patterns, trends and correlations that can provide valuable information to optimize the learning experience. Such data may include their interactions with the course content, assessment performance, time spent on different modules, and even engagement levels. One of the most significant advantages of learning analytics is its ability to personalize the learning journey for each student. Educators can understand a student's strengths, weaknesses and preferred learning style by analyzing individual data. Armed with this information, they can tailor the content and assessments to meet each student's unique needs, maximizing their learning potential.

Learning analytics allows educators to pinpoint areas where learners may be struggling or encountering difficulties. This insight enables them to address these learning gaps promptly, ensuring that students grasp essential concepts before moving on to more advanced topics. This targeted approach enhances the overall learning experience and boosts students' success rates.

Engagement is crucial in e-learning, directly impacting knowledge retention and course completion rates. Learning analytics provide valuable feedback on students' engagement levels, highlighting areas that need improvement. By using such data, instructors can design more engaging content and interactive activities fostering a positive and dynamic learning environment.

Learning analytics can also employ predictive models to anticipate students' performance and behavior. By identifying potential challenges early, educators can implement proactive measures to support struggling students, reducing dropout rates and ensuring learning experience for all.

Matters Likely to Arise From Implementing Teaching and Learning with Evolving New Technologies in Nigeria

Supporting educational practice with evolving technologies is also the desire of government, parents, teachers and other education stakeholders. But there are many observed challenges. These among others are:

Digital inequality: New technologies are not available for all users at the same time. This is particularly a major challenge for students with low socio-economic backgrounds and for schools that are disadvantaged due to their being far away from the centre. It is therefore, suggested that due to their high cost, government should make adequate provision of basic ICT tools for use in public schools where children of the poor enroll in great numbers. Government should also ensure equitable distribution of ICT tools which will also guarantee equitable use by the end users.

Difficulty in using new technology (for both instructors and students). For many instructors and students, both awareness of the usefulness and

utilization of new technologies is a problem. This problem can be resolved through intensive teacher training and retraining programmes and capacity building workshops.

Inappropriate Use of digital devices: This is related to the preceding point and can be tackled using the same measure.

Need for investments in new equipment and systems: There is near absence of basic technological equipment in public schools especially the primary level of education, which forms the foundation of learning. Because the foundation is faulty, it tends to affect students' ability to use it later in their school life. It also means that Government intervention in this area is not enough. This can be tackled through purposeful budgetary provisions by Government.

Infrastructure! challenge: The infrastructural challenges in the form of decrepit infrastructure or poorly maintained ones, lack of or inadequate computer rooms, unreliable power supply or no power supply and internet in rural communities can lead to interruption during online classes. Teachers teaching in rural schools may not have access to online resources due to the factors outlined above. To tackle these challenges, alternative power sources like solar energy to ensure uninterrupted power supply, improving internet connectivity and building and equipping of computer rooms could improve the situation.

Lack of Capacity or Training in ICT on the Part of Teachers: Many teachers in Nigeria often do not have the training they need to use new technologies. This often leads to the problem of teachers not knowing how to use them or integrate them into their lessons.

Problem of Low Awareness and Cultural Resistance: Many think that overdependence on new technologies is a form of western enslavement. Some even think that such technologies are inappropriate to their cultures or they may have negative impact on their children.

Problem of Cost: New technologies are usually expensive. This makes it difficult for some parents and school proprietors to afford and maintain. Government has to step in to subsidize them.

Conclusion

Despite the challenges, the implementation of new teaching and learning technologies in Nigeria has the potential to bring about a number of benefits such as:

Improved learning outcomes: Studies have shown that students who use evolving technologies in their classrooms tend to perform better academically than those who do not (See Carstens, Al-Bataineh & Al-Bataineh, 2021; Harris, Al-Bataineh & Al-Batianeh, 2016; Haleem, Javaid. Qadri & Suman, 2022; Valverde-Berrocoso, 2022; Lei & Zhao, 2007). This is likely due to the fact that new technologies can make learning more engaging and interactive.

Increased motivation: New technologies can help to motivate students and make them more and more interested in learning. This is because these technologies can be used to create more engaging and interactive experiences.

Improved access to education: New technologies can help to improve access to education for students who live in remote areas of Nigeria or who suffer one form of disability or the other. In this way, new technologies close gaps associated with the rich-poor, rural-urban divide.

In summary therefore, the implementation of new teaching and learning technologies in Nigeria has the potential to bring a. number of benefits. This is especially so if the challenges associated with implementation are addressed in order to maximize the benefits while minimizing the risks.

Thank you.

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