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THE POTENTIAL OF TECHNOLOGY-BASED PEDAGOGY FOR PROMOTING SUSTAINABLE EDUCATION IN MAUN SCHOOLS

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A B S T R A C T
The study investigates the potential of technology-based pedagogy in promoting sustainable learning in Early Childhood Education (ECE) within Maun Schools. Vygotsky's socio-cultural theory provided the theoretical pivot for examining the dynamics of cognitive development within a classroom setting, exploring its implications for pedagogical practices and student learning outcomes. The research employed a case study. The study used qualitative method and the instruments used comprised of interviews, questionnaires, and classroom observations were used to collect data. The sample consists of 25 participants who are 20 teachers and 5 administrators from three schools and two pre-schools and purposive sampling was applied. Through thematic analysis, the study exposes the perceptions of teachers and administrators regarding the benefits and limitations of technology-based pedagogy. Findings revealed that technology-based pedagogy stimulates 21st-century skills which include digital literacy, critical thinking, problem problem-solving among learners and teachers. There is a need for recurrent evaluation and constant improvement of technology-based pedagogy initiatives in promoting sustainable learning in ECE. It was recommended that schools should offer ongoing support and resources to help teachers effectively integrate technology into their teaching practices while promoting sustainability concepts in ECE classrooms.

1. Introduction

In today's rapidly progressing digital landscape, technology plays a gradually crucial role in shaping educational practices across all levels of schooling. While often associated with higher education or advanced learning environments, the integration of technology-based pedagogy is also gaining traction in Early Childhood Education (ECE), including pre-schools Early childhood education is focused on the critical developmental milestones, skills, and concepts that children attain during the period between birth and eight years of their lives, from social-emotional skills to the beginnings of numeracy, literacy, and critical thinking. It is also regarded as a time of "remarkable growth" that requires a specialised educational approach to ensure that children learn key skills and foundational concepts to prepare them for future academic success (UNESCO, 2020). Children need to be taught using developmentally appropriate practices since Early Childhood Education is a crucial stage that lays the foundation for lifelong learning and development. Early childhood education encompasses various programs and strategies designed to support the cognitive, emotional, social, and physical development of young children. The research aims to explore the opportunities of technology-based pedagogy in the education system of young children. UNESCO (2020) regard ECE as one of the best investments a country can make as it promotes holistic development, gender equality and social cohesion.

According to Chikwaka et al. (2024), technology-based pedagogy is a learner approach which involves the use of a variety of modern machinery in teaching and learning and is viewed as a product of the 4th industrial revolution (4IR) of the 21st century. Studies from different countries indicate that technology-based pedagogy offers a dynamic and interactive approach to sustainability education in pre-schools, harnessing the power of digital tools and resources to create immersive learning experiences (Dramaine & Daniela, 2020; Abdulmunem, 2023; Chikwaka et al., 2024).

Furthermore, the integration of technology-based pedagogy in pre-schools aligns with broader educational goals such as promoting 21st-century skills, digital literacy, and socio-emotional development. By incorporating sustainable education into early childhood curriculum through technology, educators can cultivate a generation that can perceive knowledge differently and broaden the understanding of a concept (Dreimane & Daniela, 2020). In addition, Morris and Sarapin (2020) indicated that in ECE, technology-based pedagogy plays a pivotal role in teaching and learning as it aids learners to be actively engaged in meeting the needs of diverse learners. By leveraging digital tools and online resources, teachers can enhance children's understanding of sustainability principles while fostering critical thinking skills, creativity, and global awareness.

In this context, exploring the potential of technology-based pedagogy for promoting sustainable education in pre-schools becomes not only a pedagogical vital but also a societal requisite to be able to fit in the changing world of technology globally. By integrating the transformative power of technology, teachers can motivate learners to become stewards of the environment, fostering a culture of sustainability that extends beyond the classroom and into the broader community. The technology-based pedagogy encourages the use of real-world problems in the classroom, and this takes place when using the Internet, children can research real issues happening at that moment that are related to the objectives of the lesson. This helps learners understand that the lesson being taught refers to practical problems and real people (Ali, Ali & D'Souza, 2019; Anggraeni and Listiana, 2023). By integrating technology-based pedagogies into Early Childhood Education (ECE) classrooms, teachers can expose children to diverse perspectives, knowledge, and cultural artefacts, enriching their learning experiences. Additionally, technology-based pedagogy can enhance children's cognitive development by stimulating their curiosity, problem-solving skills and critical thinking abilities.

Early childhood education is a critical period for laying the foundation of lifelong learning attitudes and behaviours. It is also an opportune time to instil values and attitudes towards sustainability, as research indicates that young children are highly receptive to environmental concepts and behaviours. The 21st-

century pedagogical technology, such as interactive media, mobile applications and educational software, has been identified as potential tools to improve the quality of Early Childhood Education (Anggraeni & Listiana, 2023). However, traditional approaches to teaching sustainable education in pre-schools often rely on didactic methods or limited hands-on experiences, which may not fully engage young learners or foster deep understanding. A research study by Dreimane and Daniela (2020) suggests that technologies such as simulations, applications and videos help to expand the dimensions of perceived information. Interactive apps and games designed for preschoolers can promote 21st-century skills such as critical thinking, problem-solving, creativity and collaboration. These apps often feature engaging activities that encourage exploration, experimentation and hands-on learning.

While technology-based pedagogy can provide new and innovative ways of living, it can also lead to digital and negative effects on children's development. Some challenges can affect the effectiveness of technology-based pedagogy in Early Childhood Education. Daniella (2021) reveals that teachers face constant challenges in refining teaching and learning techniques to keep up with the increasing demands and expectations of children who are described as digitally expectant. These challenges can hinder the effective integration of technology and limit its potential benefits. UNESCO (2020) reported that most children in Sub-Sahara do not have equal access to technology due to socioeconomic disparities, and it can create inequalities in learning opportunities. Schools in some areas may lack the essential infrastructure, such as reliable internet and up-to-date devices, to effectively support technology-based learning Daniella (2021). On the same note, the educational value of digital content varies widely, and some applications and programs are not developmentally appropriate or aligned with educational goals, affecting the effectiveness of the pedagogy. (Anggraeni & Listiana, 2023).

2. Theoretical Framework: Sociocultural Theory

Vygotsky's sociocultural theory underlies the significance of social interaction, cultural tools, the zone of proximal development (ZPD), scaffolding, play and learning in the cognitive development of children.

Cultural Tools

Vygotsky emphasised the influence of cultural tools, such as language, signs, symbols, and artefacts, in shaping cognitive processes and learning. These cultural tools are passed down from one generation to another and facilitate the learner's interaction with the world (Mahn and John-Steirner, 2012).

Zone of Proximal Development (ZPD)

The ZPD refers to the gap between a learner's actual developmental level and their potential development with the assistance of a more knowledgeable other. Vygotsky argued that learning is most

effective when it occurs within ZPD, where learners can take part in tasks that they cannot perform autonomously but can complete with assistance or scaffolding from a teacher, peer, or more skilled individual (Van der Veer, 2012).

Scaffolding

Scaffolding refers to the support provided by a more knowledgeable individual to assist learners in their ZPD. The scaffolding process involves adjusting the level of support according to the learner's needs, gradually withdrawing support as the learner becomes more capable. This process helps learners internalise new knowledge and skills (Miller, 2011).

Play and Learning

Vygotsky highlighted the significance of play in a child's development. He believed that play provides a zone of proximal development in which children can engage in activities beyond their current developmental level. Through play, children can experiment, imagine, and practice new skills in a less structured and more enjoyable environment (Crain, 2015; Golinkoff & Hirsh-Pasek, 2016).

Vygotsky's sociocultural theory of learning has had a significant influence on educational practices and has been used to inform teaching methods, curriculum design, and classroom interactions (Van der Veer, 2012). He was of the viewpoint that children are active in their learning, and what they experience contributes a major part in influencing their learning. This theory focuses on the role of cultural tools in influencing the development of individuals. The technology-based pedagogy can serve as a powerful cultural tool in this 21st century that extends children's ZPD, enabling them to engage in meaningful learning experiences (Mahn & John-Steirner, 2012). In this context of the 21st era, technology serves as a cultural tool that mediates children's interactions with the world. By integrating technology-based pedagogies into ECE classrooms, teachers can expose children to diverse perspectives, knowledge, and cultural artefacts, enriching their learning experiences.

Furthermore, technology can be used to scaffold children's learning experiences within their ZPD. Interactive educational apps, games, and digital platforms can provide tailored support, challenging children to reach their full potential while ensuring tasks are neither too easy nor too difficult. Adults can help children navigate digital tools effectively, promoting deeper understanding and skill development (Van der Veer, 2012; Mahn & John-Steirner, 2020). Vygotsky highlighted the significance of social interaction in the learning of children to enhance their cognitive abilities (Crain, 2015; Golinkoff & Hirsh-Pasek, 2016), which are more vital in the 21st century. Technology can facilitate collaborative learning experiences, allowing children to engage with peers, teachers, and experts in meaningful ways. In addition, scaffolding and reciprocal teaching are effective educational strategies based on Vygotsky's ideas.

3. Research Questions

1. What are the benefits of using technology-based learning in the 21st century?
2. What are the challenges associated with using technology-based pedagogy in preschools?
3. What are the most effective types of technology that can promote educational sustainability in early childhood**?**
4. How might educators leverage technology-based pedagogy within Early Childhood Education (ECE) to cultivate 21st-century skills?

4. Method and Design

The researchers used a qualitative case study. Case studies strive to portray 'what it is like' to be in a particular situation, to catch the close-up reality and thick description of participants' lived experiences of, thoughts about and feelings for a situation. They involve looking at a case or phenomenon in its real-life context, usually employing many types of data (Robson 2002 in Cresswell & Cresswell, 2018). This design will help the researchers to find the potential of technology-based pedagogy in its real context and recognise that the context is a powerful determinant of both causes and effects.

4.1 Population and Sample

The population in this study includes all primary schools in Maun that may potentially implement technology-based pedagogy for promoting sustainable education. This encompasses both public and private primary schools within the geographic area of Maun. This research's sample is three (3) private primary schools and two (2) preschools. A sample is viewed by Atieno (2014) as a small proportion of a population selected for analysis. Therefore, a sample is a fraction of the targeted population and hence presents the outcomes of the study being carried out. In this study, twenty-five respondents are the sample, twenty (20) Early Childhood teachers and five (5) administrators based on their expertise, roles, and influence in Early Childhood Education.

4.2 Sampling Procedures

The researchers used cluster sampling techniques to collect data from schools and preschools that are in the same geographical area for easy access to schools. Also, purposive sampling was employed to collect data from twenty (20) Early Childhood teachers and five (5) administrators based on their expertise, roles, and influence in Early Childhood Education. Purposive sampling is a type of sample that is done according to the purpose of the study, the members of a sample are selected (Bhardwaj, 2019). Purposive sampling was convenient in this study as the researchers wanted to get information from the ECD teachers and heads as well as give reliable data because of their expertise.

4.3 Instruments

Research instruments are media used by researchers to elicit information from the respondent. The researchers conducted interviews with teachers to understand their perspectives on technology-based pedagogy and sustainable education. The interviews were face-to-face, as the researchers were able to rephrase some of the questions to get the relevant data. Interviews provide rich qualitative data that illuminate respondents' beliefs, attitudes, and practices (Cresswell & Cresswell, 2018) regarding technology-based pedagogy and sustainable education, offering valuable insights for program improvement and policy development. Also, researchers managed to interpret the responses from the facial expressions. Furthermore, the unstructured questionnaires were administered to the administrators to obtain qualitative data and obtain information that could not be withdrawn from other instruments used. In addition, observations were carried out to document the use of technology tools, teaching strategies, and student engagement levels related to sustainability topics. Researchers used structured observation protocols to record specific behaviours, interactions, and environmental factors relevant to technology-based pedagogy. Observations offer real-time data on classroom dynamics, instructional methods (Cresswell & Cresswell 2018, Cohen, Manion & Morrison 2017) and the integration of technology and sustainability concepts, allowing for distinct analysis and identification of patterns and best practices.

4.4 Data collection procedures

Cohen, Manion and Morrison (2017) reveal that data collection procedures give operational details such as how, when and who administers the instruments during the collection of the data. To move around schools in the district collecting data, the researchers were granted data collection permission by the Principals of the schools. The researchers used a combination of methods to triangulate findings and ensure the validity and reliability of the data collected since each instrument has its strengths and weaknesses. Triangulation is one method for increasing the validity of findings by deliberately seeking evidence from a wide range of sources and comparing findings from those different sources (Brikci & Green, 2007). Before carrying out the research, respondents were informed about the topic and the research instruments to be used. An audiotape was used to record data from interviewees, and the researchers sought respondents' prior permission. This was done to check whether the views were recorded correctly during the interview section. Data was recorded verbatim on notepads.

4.5 Data analysis procedures

A qualitative analysis was employed to transcribe and code interviews, questionnaires and observation data using thematic analysis to identify recurring themes and patterns related to technology-based pedagogy and sustainable education. The data was analysed with scrutiny to either confirm or disconfirm the researchers' sub-research-questions. Smart art was also used to coin the analysis for easy

understanding of the findings obtained.

4.6 Ethical considerations

When conducting research, it is paramount to address several ethical considerations to ensure the well-being, confidentiality, and rights of participants. The researchers obtained informed consent from all participants, including teachers and administrators, before their involvement in the study. Also, researchers were able to safeguard the confidentiality of participants' personal information and data collected during the study. Honesty, transparency and integrity in all aspects of the research, including data collection, analysis, and reporting, were maintained. Furthermore, respect participants' autonomy and decision-making abilities throughout the research process. By addressing these ethical considerations, researchers conducted a study on the potential of technology-based pedagogy for promoting sustainable education in Maun primary schools in a manner that upholds the rights and well-being of participants and ensures the integrity and validity of the research findings.

5. Findings and discussion

What are the benefits of using technology-based learning in the 21st century?

Several benefits were highlighted by respondents. One respondent acknowledged the idea that children are growing up in a digital age and they will need skills to use technology in their daily lives. When asked about the opportunities they see in the usage of technology-based pedagogy, the answer was, "*It will help children keep up the pace of the 21st century and easily adapt to any environmen*t". Also, another one said that "*learners are part of the society and the society in this era needs a more digital literate society"*. Furthermore, another respondent indicated that the use of radios and televisions helps to motivate learners and are always engaged throughout the lesson.

The research findings revealed that technology-based learning tools, such as radios and televisions, can increase learner's engagement and motivation by providing energetic and interactive learning experiences. The respondents highlighted the importance of using different technologies to motivate children and enhance the cognitive process. Research done by UNESCO (2020) suggests that children are more likely to be actively involved in learning when technology is integrated into instructional activities, leading to improved academic outcomes and retention of information as well as sustainable education. This is in line with what Dreimane and Daniela (2020) suggested, that technologies such as simulations, applications and videos help to expand the dimensions of perceived information and lifelong learning.

Several respondents indicated that technology-based pedagogy makes education more inclusive and accessible to children with different abilities and learning styles. Also, gain more sustainable skills that are needed for their development and to use later in life. One respondent, when interviewed, indicated that if children are exposed early to technology, they can develop digital literacy skills, critical thinking and problem-solving skills, which are crucial for sustainable academic success and lifelong learning. The research findings indicated that both teachers' and students' early exposure to technology helps children develop digital literacy skills essential for future academic and career success. Also, can develop skills that are essential for the 21st century, which are solving complex problems, critical thinking, developing different forms of communication and leadership skills, and improving motivation and productivity.

What are the most effective types of technology that can promote educational sustainability in early childhood?

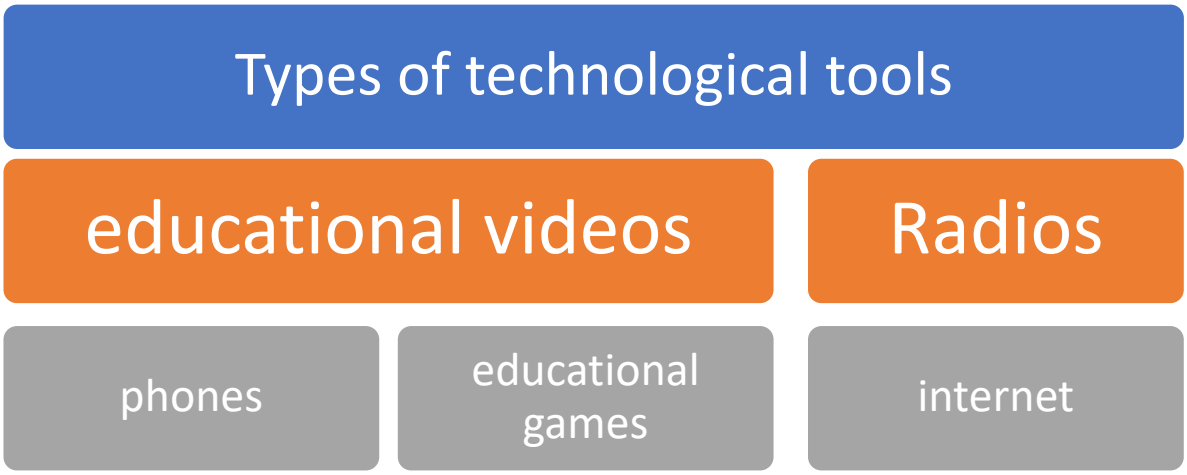

Figure 1: Types of technological tools

Figure 1 shows the different technological tools used by respondents. Most respondents interviewed indicated that they use their phones to play music and rhymes to motivate children. Laptops are used to do administration work. The research findings revealed that most teachers use radios and television as technological tools in the teaching and learning of children. This is in line with what Chikwaka et al. (2024) found out that children are motivated by the use of smartphones and video games. The researchers deduced from the observations that most schools are still using late 19th-century technology in the teaching and learning of 21st-century children. Promoting 21st-century skills in preschools through technology-based pedagogy requires a thoughtful selection of tools and approaches that align with the developmental needs of young children.

Televisions were also seen during observation. Respondents indicated that they use the television as a storytelling tool and also allow pre-schoolers to develop critical skills, reasoning and problem-solving skills. In some pre-schools, the internet was accessible to everyone, and one response indicated that it made their work easy to teach and help download video games. The research findings indicate that teachers use a few different types of tools to share ideas and learn about the world through storytelling.

What are the challenges associated with using technology-based pedagogy in preschools?

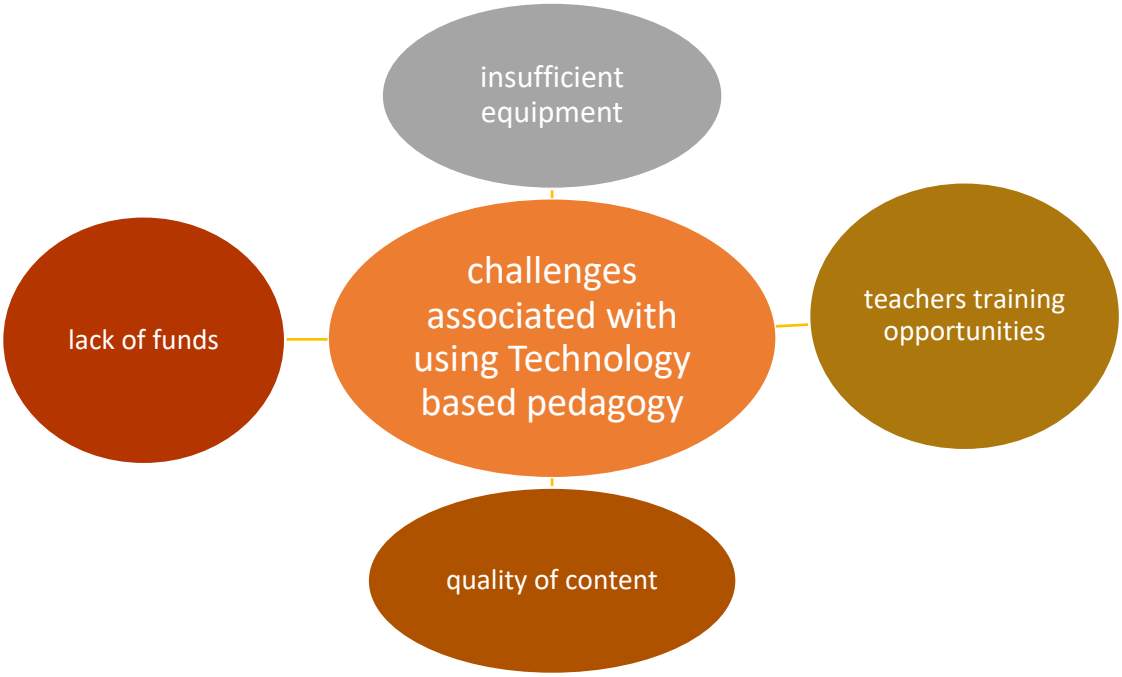

Figure 2: challenges associated with using Technology based pedagogy

Figure 2 above highlights the challenges faced by respondents when implementing the technology-based pedagogy. Most of the respondents pointed out that the educational applications that are available on the internet have poor content and that quality content is available when teachers or the school has to subscribe. Furthermore, some said that "*sometimes the content will be overloaded with information, and it becomes a challenge to use such applications and align with the objectives of the lesson"*. Also, the respondents highlighted that they do not have training opportunities for using technology to be effective and efficient in the teaching and learning of children. Although in some schools, respondents acknowledged the support and training offered by their schools, it would be limited or relevant to the 21st-century goals of the digital world. The research findings revealed that most schools have challenges with the quality of content that is available on the internet. Also, the findings indicate that teachers do not have the necessary training or expertise to effectively integrate technology into their lessons. Also, it was noted that internal and external staff development is not considered paramount in professional

development opportunities to equip teachers with the skills and knowledge needed to use technology effectively.

On another note, the researchers observed in one school that the whole school shares one gadget (radio/television), which makes it difficult for teachers to use the methodology in teaching and learning. When one respondent was interviewed, they indicated that they have little equipment they use in implementing the pedagogy, especially the software programmes which need a subscription. The findings revealed that insufficient equipment is another challenge faced by teachers. This indicates that the insufficient equipment used by teachers limits children's exposure to the digital world since more applications are invented every day, both hardware and software. This also indicates that there is no selection of digital tools that can help children strive and have lifelong learning, which will match with the 21st century.

How might teachers leverage technology-based pedagogy within Early Childhood Education (ECE) to cultivate 21st-century skills?

The respondents indicated that teachers can use technology-based pedagogy in different levels of teaching so that it can arouse critical thinking skills and help children develop problem-solving abilities from an early age. Also, it was highlighted that the methodology can be integrated with other methods to achieve the intended results since there are some challenges to acquiring appropriate and relevant tools that can boost children's lifelong learning. The findings indicated that Technology-based pedagogy could be used to develop practical life skills, such as digital literacy skills since children are living in the digital world.

Furthermore, one respondent mentioned something that collarets with the findings from Johns (2022) that teachers can use digital tools to support learning and motivating children by stating that " teachers can incorporate the digital tools to support children in developing these essential skills for success in the 21st century'. In an interview with some respondent indicated that "it's better to catch them young", "co-learning and scaffolding can help us to lay a firm foundation in this era of the digital world". Technology is more effective for learning when teachers interact or co-view with young children. The findings indicate that technology-based pedagogy can be more effective when children are monitored at an early age. This is in line with Vygotsky's theory that these tools are more similar to scaffolds, and teachers can use the tools as scaffolds to help children reach their Zone of Proximal development.

6. Conclusion

The researchers concluded that there is a need for ongoing evaluation and constant improvement of technology-based pedagogy initiatives in promoting sustainable learning in ECE. Additionally, technology-based pedagogy provides opportunities for learners to access high-quality educational concepts and builds a strong foundation in Early Childhood Education. Furthermore, technology empowers children with 21st-century skills, which are collaboration, critical thinking, problem-solving, and digital literacy, which are essential components of sustainable development. However, it is crucial to acknowledge the potential and challenges associated with technology-based pedagogy for sustainability education and strike a balance between both. These include issues of digital equity, privacy concerns, and the need for ongoing professional development to support educators in effectively integrating technology into their teaching practices.

7. Recommendations

- Schools are encouraged to provide training and professional development opportunities for teachers to enhance their knowledge and skills in integrating technology into their teaching practices.
- Schools are urged to encourage teachers to participate in in-service courses and workshops focused on technology-based pedagogy.
- External staff development, workshops, seminars, and online courses can be offered regularly and free of charge.
- Teachers are encouraged to use 21st-century applications in teaching and learning.
- Schools are advised to offer ongoing technical support and resources to help teachers effectively integrate technology into their teaching practices.
- The government is urged to assist all schools, regardless of their status, with comprehensive programmes providing computers, internet access and other necessary technology.
- Schools should also offer incentives in the form of technological tools to motivate teachers to use technology-based pedagogy.
- Parents are encouraged to buy different technology tools for children so that they can develop skills needed for the 21st century and avoid cultural shock as they encounter the gadgets for the first time.

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