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EFFECTIVE USE OF 3D PRINTING TECHNOLOGY IN TACKLING CHALLENGES IN EDUCATION FOR DEVELOPING COUNTRIES

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Abstract
The innovative progresses within the world nowadays have driven to the improvement of approaches and strategies that are imaginative within the conveyance of instructive substance. The utilization of advances like mixed media has greatly improved the teaching and learning processes which as a result have made education curiously and consequently propelling. 3D printing is one of the innovations that have as of now begun to invade into numerous scholarly circles. The advancement of 3D printing innovation encompasses a parcel of potential for application in developing countries especially the education sector. When it comes to later innovations, the focal points of 3D printing make it one of the foremost promising advances. This work examines the openings, challenges and prospects of application of 3D printing innovation in education in developing countries. In these developing countries, 3D printing offers numerous benefits especially in the educational sector. These benefits include but are not limited to improving the students learning process and experience as well as improving the teaching capabilities of the teacher. Hence the need to deploy 3D printing in the curriculum of developing countries is undeniable.

Keywords: 3D printing, technology, developing countries

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1.0 Introduction

Innovation has likely had more of an effect on changing human history than any other field. Advances such as the light bulb, the steam motor, or, more as of late, the car, plane, and World Wide Web, have opened up unused conceivable outcomes and made our lives way better, but the genuine damaging nature of innovation takes time to gotten to be clear. It is broadly accepted that added substance fabricating (3D printing) may be one of these advances. The development of these unused advances has had a significant effect on how individuals associated with their environment and with each other. Innovations such as remote systems, long separate communications, and other imaginative advances have made strides the stream of data around the world. Instruction frameworks point to receive and apply modern and inventive advances to progress learning substance, introduction and conveyance. One of his emerging innovations, 3D printing innovation has awesome potential within the advanced age. With the later rise of cheap 3D printers, a few proclaim the starting of an unused mechanical insurgency. Various studies have detailed positive results for 3D printing innovation, and numerous created countries have received the innovation and coordinate it into their educational program. Schools and libraries around the world are making these effective devices accessible to understudies within the classroom.

1.1 Summary of Background

3D printing (also known as additive manufacturing, rapid prototyping, or stereo lithography) is the creation of three-dimensional physical objects from 3D computer models made utilizing computer-aided design/manufacturing/engineering (CAD/CAM/CAE). The method of 3D printing innovation makes objects utilizing machines that expel liquid fabric layer by layer in three measurements until the required question is shaped. It could be a sort of added substance fabricating strategy that can quickly deliver indistinguishable duplicates of the same advanced demonstrate (Chae et al., 2015; Sander et al., 2017). Some time recently beginning the 3D printing process, the protest must be outlined utilizing specialized software such as OpenSCAD or other program that makes strong 3D CAD objects. Another way is to induce free off-the-shelf objects from online open communities or databases like Thingiverse or Smithsonian X 3D. The question is at that point transferred for cutting utilizing computer program such as Cura, planning the 3D computerized demonstrate setup for printing. At that point interface your 3D printer and run the printing prepare. Conventional printers utilize fluid ink or powder (toner) to print, but 3D printers utilize liquefied plastic ink. The foremost commonly utilized commercially accessible thermoplastic polymers are acrylonitrile butadiene styrene (ABS) and polylactic corrosive (PLA) (Rosenzweig et al., 2015). The liquid plastic is connected layer by layer onto the print bed and dries rapidly, building extra layers on beat of the past until the 3D protest is shaped.

1.2 Statement of Problems

In today's innovative world, conventional instructing strategies are getting to be futile. Twentieth-century schools centered on professional and household work abilities and information, and on planning the working lesson and students for their part as specialists in a mechanical society (Cremin, 1988). The 21st century specialists require assortment of abilities that offer assistance them coordinated into today's mechanical work environment. In expansion, 3D printing empowers a more intuitively learning prepare, which speaks to a flight from the normal classroom learning prepare, where data is frequently transmitted in as it were one course, from instructor to understudy. It ought to offer assistance to bridge the hole between instructors. This approach gives understudies a sense of achievement. This makes them mentally surer and feel more included within the instructive handle.

1.3 Objectives of the Study

The advancement of 3D printing innovation has awesome potential for application in instruction in developingcountries. This investigate work will give an outline of the writing on the application of 3D printing in instruction frameworks and survey the requirement for utilizing 3D printing as an critical education instrument in developing countries. At the same time, we are going to examine opportunities, challenges and prospects for application within the field of education and propose feasible implementation strategies.

2.0 Literature Review

Early 3D printing innovation to begin with risen within the late 1980s and was at that point called Rapid Prototyping (RP) innovation. This handle was initially conceived as a quick and cost-effective way to form models for item improvement in industry. Interests, the primary obvious application for RP innovation was submitted in Japan 1981 by a specialist Hideo Kodama. He created a layer-by-layer fabricating approach utilizing photopolymers made by polymerization beneath UV light. Kodama was incapable to record obvious application for this innovation, but in advanced times he is most commonly considered the initial innovator of this fabricating framework, an early form of the Sterolithography (SLA) machine. But in truth, the beginnings of 3D printing can be followed back to 1986, when he was granted the primary patent for a stereolithography (SLA) gadget. This obvious had a place to Charles Frame, who designed the primary SLA machine in 1983. His SLA-1, the first commercial RP framework, went through thorough testing some time recently he was presented and sold within the late 1980s.

As of now, the accessibility of 3D printers in developingcountries is constrained to colleges with committed workshops such as designing offices and fabricating research facilities (FabLabs). Fab labs are open spaces where business people can get to computerized fabricating devices, learn more, and propose projects. Developingcountries confront numerous wellbeing issues, counting removal. Uganda and South Sudan have delivered 3D printed prostheses utilizing 3D printing innovation. Due to the need of adequately specialized prosthetists, persistent scans are sent to diverse parts of the world where they are planned as 3D advanced models and the records are sent back to print the prosthesis. In a few cases, 3D limbs have come to be utilized as an elective to hand-made limbs. In spite of the fact that 3D limbs are not of higher quality than hand-made limbs, most patients incline toward his 3D limbs since it takes less time to fit his 3D limbs compared to ordinary limbs. Hence, 3D printing offers a quicker and cheaper approach than routine appendages to address the prosthetic appendage circumstance in developingcountries. 3D printing seem be a lifesaver in developingcountries where healthcare is struggling to keep up with therapeutic request and tall restorative costs. In Haiti, citizens and aid specialists are still battling to recoup from the impacts of his 2010 seismic tremor. Subsequently, a few research facilities are utilizing 3D printing to form models for future printing of certain fundamental therapeutic supplies that are utilized when required. B.; Umbilical clamps, finger braces, plaster casts. The designed prototypes are 3D printed for coordinate utilize at neighbourhood clinics utilizing on-demand fabricating.

Also, in Haiti, 3D printing innovation is being used to print shoes for destitute school children. A 3D-printed vein locator for newborn children has been created at a Kenyan FabLab. This model will empower doctors to find the veins of newborn child patients and control imperative venous needles in newborn children, a regularly troublesome assignment. In the interim, analysts at the College of Trinidad and Tobago are utilizing 3D printing to make anatomical models. This innovation permits specialists and restorative offices to

investigate the benefits of 3D printing in pharmaceutical. The investigate bunch is working to development the application of 3D printing innovation in the medical field. One of the most goals for long haul is to utilize 3D printing to carry out surgeons' preoperative arranging, thereby speeding up the surgical process.

In Colombia, 3D printing is being utilized in innovative ways in the design plan industry to make modern and inventive design clothing and adornments. In India, 3D printing is being utilized to offer assistance waste collectors by making plastic squander reasonable. The plastic is at that point prepared into printer fiber. This decreases the taken a toll of his onsite 3D printing benefit. 3D printing innovation is a developing innovation in colleges, colleges and tall schools. This innovation has significantly changed the teaching and learning handle. 3D printing may be a revolutionary and revolutionary innovation that brings better approaches to memorize and get it concepts that are exceptionally troublesome to realize with conventional strategies. Science and innovation is an important aspect of economic improvement in created countries. Developingcountries moreover require science and innovation to progress the lives of their citizens. It is anticipated that this 3D printing technology will proceed to progress science education in developingcountries. In developed countries, 3D printing is basically utilized by understudies to form models and prototypes of things without the costly apparatuses required by subtractive strategies. Understudies plan and construct physical models. This course permits understudies to memorize and attempt out this inventive applications of 3D printing. It can be exchanged to developing countries.

3.0 Problem Definition with Proposed work

When it comes to learning, you can understand principles and concepts better if you can put them into action rather than passively learning by reading books. 3D printers offer new ways for teachers to teach a variety of school subjects by providing students with hands-on experiences and experiences. These encourage creativity and are great educational tools for students of all ages. 3D printing is an interactive technology that encourages student learning. When it comes to recent inventions, 3D printing is one of the most promising technologies due to its advantages. However, like almost any other process, 3D printing technology has drawbacks that should be considered before deciding to use it in education. 3D printing challenges include:

- **Availability of 3D printing experts -** Managing most 3D printing technologies requires skilled personnel. Therefore, to make the most of 3D printing, developing countries need a sufficient number of professionals who can design, model and manufacture a wide variety of products. However, skill levels vary by technology. 3D printers work just as effectively as the humans who operate them. As reported by McMenamin et al. (2014) with 3D printed parts, “the output is as good as the input”. Zuberbia et al. (2016) also took the view that the operator is limited without his 3D design skills required for 3D printing. These necessary skills apply not only to setting up a successful print, but also to properly maintaining your machine. So far, there is a shortage of professionals capable of designing and manufacturing various products using 3D printing technology, and there are very few skilled 3D printing operators in developing countries (IshengomaandMtaho, 2014). More training is needed to increase the number of experts in 3D printing technology in developing countries. Educational institutions can also leverage a particular organization's 3D printing expertise to train employees in the technology. These experts can also educate teachers on 3D printer best practices.

- **Lack of awareness of the existence of 3D printing technology -**Science underscores the huge opportunities that 3D printing offers, and if the end user is not fully aware of this technology, it can leave behind only nonsensical ideas. In developing countries, awareness of this technology is below average and adoption rates are even lower. Due to the limited understanding of 3D printing technology in the education sector in developing countries, the utilization of this technology is very low. The result is undermining acceptance and integration in developing economies. Users should be educated about the possibilities of this technology and how to use it in education. Therefore, there is a need to increase awareness of 3D printing technology to raise awareness among educators and educate them about the benefits of adopting this technology in the educational field. All stakeholders and government agencies must create an environment that enables proper education and awareness of 3D printing among students and teachers.
- **Equipment costs** -3D printing technology is still developing, so equipment and material costs are high. The high initial cost of most high-quality 3D printers may discourage some individuals and institutions from purchasing machines. This is even more true in developing countries, where low standards of living can make affordable products seem more expensive in developed countries. If the cost of his 3D printing of products is high compared to other options. People will choose the next best option available. However, this cost varies by technology, with FDM (Fused Deposition Modeling) printers appearing to be the most economical option. Institutions are therefore encouraged to identify the specific technology that best meets their functional needs while remaining affordable. One way educational institutions can make 3D printers available is by partnering with his OEM of these 3D printers. Through such partnerships, mutually beneficial agreements can be reached between educational institutions and manufacturers, including the provision of his 3D printers and their spare parts when needed to enhance teaching and learning.
- **Limited materials -** 3D printing can be used to create items from a variety of plastics and metals, but the range of raw materials available is not exhaustive. This is because not all metals and plastics are strong enough to be 3D printed. Additionally, many of these printable materials are not recyclable. Today, 3D printers use plastics, resins, ceramics, and metals to manufacture products. Mainstream 3D printers are not yet capable of mixing the various materials required for printing. As a result, the quality and strength of multi-material blended products are compromised. For example, printing models that contain both rubber and metal remains a challenge. On the other hand, large commercial 3D printers that support mixed materials are prohibitively expensive for the majority of users in developing countries. Considering that additive manufacturing technology has made great strides in recent years, the material challenge is not expected to last long. when new material is introduced
- **Electricity -** Epileptic power conditions in most developing countries is one of the shortcomings of the development of 3D printing. Like any industrial machine, 3D printers rely on electricity to operate and require a constant power supply as some printers can fail to print even with a temporary shortage (However, modern printers can resume printing after a power failure.) Abnormalities in the power supply can also cause damage to the machine and shorten its service life. A solution to this problem is the use of backup generators or solar panels. They are already being used in some secondary schools and universities to replace government-supplied electricity when running computer labs and other experimental projects. Students in several Nigerian universities are developing solar panel systems for their final projects. These projects may be aimed at providing the power needed for 3D printing. Another solution to the

epileptic power problem is to use an uninterruptible power supply (UPS) as an additional source of power. This is necessary when power occurs frequently but inconsistently. A UPS device prevents printing stalls by providing power during a power outage long enough for mains power to be restored. From a power consumption perspective, 3D printing is significantly more efficient than traditional manufacturing methods. According to a study conducted by Nwaeche (2019), the electrical energy required for his 3D printing of gears was 9.21 kJ, while another manufacturing technique required him 323 kJ. This indicates a significant energy saving effect when the former is used.

- **Time consumption -** 3D printing has been described as a slow process and as such may be considered too time-consuming for classroom learning. This is observed in the time taken to print objects; an object as "small as a penny" may take up to 10 min (Maloy et al., 2017). 3D printing is said to be a slow process and is considered too time consuming for classroom learning. You can see this in the time it takes to print the object. Objects "as small as a penny" can take up to 10 minutes (Maloy et al., 2017). There is a possibility that work time will be lost due to printing failure. However, the more specialized an operator is, the less often these occur. However, 3D printers do not require the operator to physically pay attention to the machine during operation. Instead, it can run for hours without external input. Schools can therefore plan lessons with time to set up prints, time to print, and time to analyze and post-process models. With proper planning, you can significantly reduce the time required for 3D printing.
- **Restricted build size -** 3D printers on the market today have small build chambers, limiting the size of the parts they can print. Anything larger will need to be printed in separate parts and assembled after manufacturing. This can increase the cost and time spent on large parts, as more parts must be printed on the printer before the parts are manually assembled. Due to advances in technology, it is expected that 3D printing technology will be used to print large objects in the near future.
- **Material mismanagement -** Another potential challenge when introducing 3D printing is the use and management of materials. Most desktop 3D printers are based on often-misused polymer materials. According to Afolabi et al. (2019), a serious threat to the 3D printing revolution lies in the practice of 'frivolous printing'. This is even more true in education, as 3D printing novices tend to enjoy the thrill of new technology by making multiple unnecessary and failed prints. Such improper management not only has an economic impact, but can also have environmental impacts if materials are not recycled or disposed of properly. This can be addressed through proper supervision of new users of technology. With proper guidance from an experienced user, the number of wasted or failed prints can be reduced. Institutions interested in protecting the environment and optimizing the use of materials can also purchase filament recyclers for 3D printers. These machines convert plastic waste into new filament (plastic for FDM 3D printing) that can be used for other print jobs. This helps reduce plastic waste while being environmentally friendly.
- **Copyright issues -** Most 3D CAD models are available online in open source format, allowing anyone to download the model and print the physical object. Recently, traditional companies in the manufacturing and engineering industries have been chasing sites that share his 3D models online, claiming that the home printer destroys their intellectual property. 3D printing can raise legal issues in managing digital rights to prevent online file sharing. Copyright laws in developing countries have not yet enforced laws governing the sharing and use of 3D models on the Internet. However,

as 3D printing becomes more popular, copyrighted materials are becoming increasingly difficult to print and increasingly difficult to identify.

4.0 Potential Application Areas of 3D Printing Technology in Education in Developing Countries

The education system plays an important role in aiding people achieve their full potential. 3D printing can revolutionize the learning experience by helping students interact with the subject matter. Affordable 3D printers in schools may be used for a variety of applications which can aid students in finding their field of interest easier and faster. The following are some of the potential application areas of 3D printing technology in education in developing countries:

- Teaching 3D design in engineering education provides students with hands-on opportunities to learn concepts taught in the classroom or that they are likely to encounter in the industry. Developing teaching and learning models for use in classroom teaching also helps young engineers improve their skills and make it easier to see the results of the design process from his 3D pattern prints.
- Introducing 3D printing in lab workshops gives students the opportunity to participate in hands-on 3D printing projects. These projects help realize various benefits of this technology. This also helps the faculty ensure that all students in her course are introduced to her 3D printing. In addition, simple laboratory equipment can be designed and printed without the need for expensive purchases. This is very useful in scientific fields where some equipment is not readily available and very expensive.

- Student teams are teams that help students use their free time to work on extracurricular projects and represent the school in competitions and extracurricular events. If teams like this were encouraged to work on projects related to his 3D printing, the students' experience with technology would be greatly enhanced. Students can also find ways to apply 3D printing technology to other traditional team projects, thereby improving team performance and educating students through hands-on experience.
- Another strategy to introduce 3D printing into education is to offer 3D printing services in school libraries. In addition to books, some libraries may also have amenities that are essential to the student learning process that are not available elsewhere on campus. These 3D printing services give students access to her 3D printer and other related equipment to bring their designs to life in a controlled yet challenging environment. However, rather than relying on performing operations through trial and error, students are free to unleash their creativity while being guided by competent and trained staff.
- With the help of educational partnerships, 3D printing technology can be used in the teaching and learning process. This is common in developed countries looking to adopt 3D printing technology. Institutions in developing countries can enter into partnerships with public or private sector stakeholders. With real, conscious effort, government agencies can help educational institutions use this 3D printing technology in schools, and private sector organizations can also donate this 3D printers and other related equipment.
- 3D printing outreach programs in high schools help high school students become more familiar with technology. Outreach programs are run by colleges for a variety of reasons, from college promotion to some form of community service. These outreach programs typically focus on getting students involved in topics not easily covered in

the curriculum. 3D printing is therefore ideal for such outreach training. Such an experience could have many benefits for both middle school and college students, and while 3D printing is still a novelty in universities in developing countries and few have adopted it, these outreach program is encouraged by high-performing colleges and universities.

- Governments play a key role in the adoption of 3D printing technology. This may take the form of legislation, infrastructure and facility development. They can create guidelines that not only encourage, but mandate, 3D printing technology for colleges and universities that award engineering and science degrees. This ensures that each institution strives to meet the standards that other institutions meet internationally. In addition, it provides opportunities for the academic community to research and advance technology. Facilities such as manufacturing labs and schools may be established by governments solely to train potential trainers in 3D printing and related advanced manufacturing techniques. Something like this already exists in some developed countries, such as advanced manufacturing laboratory schools (labschools) in the United States specifically designed to improve students' additive manufacturing skills (Bull et al., 2015). Once such a 3D printing center is established, teachers will be trained to help further develop this skill.

5.0 Result and Discussion/Recommendations

3D printing has the potential to revolutionize multiple sectors of the developing world economy and should not be taken lightly. Most students and even educators have little or no relevant knowledge of technology. Even those who are tech-savvy have little ability to promote it in their education.

3D printing is not yet a popular manufacturing technology in developing countries, but there are various efforts underway to adopt the technology. This includes certain companies such as Nigerian Foundries Limited and Elephab, who have taken bold steps to pioneer his 3D printing in the industry. 3D printing offers many advantages in education. These benefits include not only improved teaching skills for teachers, but also improved learning processes for students. Therefore, the need to integrate 3D printing into the curriculum cannot be denied.

There are some challenges when considering using 3D printing, but we also know that these challenges are not without solutions. Following these solutions will ensure that this emerging technology spreads across different sectors of the economy. 3D printing can therefore be used in the educational arena of science and engineering programs through various strategies such as partnerships, curriculum integration, and government interventions. These strategies have the potential to increase acceptance and awareness of 3D printing while providing quality learning opportunities for students.

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