

## The Use of 3D Printing Technology in the English Language Classroom

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### ABSTRACT

The approach towards education in this 21st century era has evolved and many changes are taking place from time to time. The existence of 3D printing in all sectors and aspects of human lives makes things more convenient and easily accessible. Students and educators coming from all walks of life and learning institutions need to grab the opportunity to learn how to make use of the 3D printing in teaching and learning process. Digitization of subject content through 3D printing has made teaching and learning English language more interactive. Research has shown educators witnessed that students are now more capable and independent in supplying information due to utilizing 3D printing technology. The spotlight of the learning process is no longer on the teachers but the learners. 3D printing is a tremendous breakthrough for the education world. Even though the challenges and limitations of the usage of 3D printing in the classroom addressed are true, more discovery is required in order to overcome those obstacles. The purpose of this study is to review the literature on the utilization of 3D printing in the English language classroom. This study is significant as it focuses not only on the use of 3D printing in English classroom but also on the advantages and challenges of using 3D printing technology in English language learning and teaching. Therefore, the interpretation of the mentioned elements offers the teachers, students, and educators a better understanding of the concepts.

**Keywords:** 3D printing; English language; English learning; English teaching; classroom.

### Introduction

The origins of 3D printing are firmly embedded in engineering, specifically within industry and manufacturing, where the research and development of new products include a process of creating a prototype to ensure a design meets all specifications, is sized correctly for the intended application, and does not create unanticipated interactions and so forth. Historically, prototyping included either a casting or milling process to create the part, frequently at substantial cost for re-tooling and materials, as well as several weeks for manufacturing a single prototype. The need for faster and less expensive methods for creating functional prototypes began to

gain traction in the 1980s with additive manufacturing process, also known as three-dimensional (3D) printers. Elrod (2016) also believed that 3D printing, also known as additive manufacturing, is a growing field for many professionals, including those in education. With 3D printers, it became possible for prototypes to be generated in days rather than weeks, at the cost of pennies or dollars rather than thousands or tens of thousands of dollars and directly from a Computer-Aided Drafting (CAD) drawing (Van Epps, Huston, Sherrill, Alvar, and Bowen 2016).

3D printing is commonly known as the third industrial revolution in manufacturing an acceptable alternative to traditional manufacturing with its unique capacity

for design innovation, digital fabrication, and data management (Roy, 2017). He further explains that Project-Based Learning (PBL) with the infusion of critical thinking in 3D printing syllabus can be further enhanced through hands-on exposure to procedural design and prototyping, group collaboration, peer review, and authorized online document.

The first and earliest 3D printing technology which was referred as Rapid Prototyping (RP) technology took a breakthrough in the late 1980's. This is because the processes were originally conceived as a fast and more cost-effective method for creating prototypes for product development within industry (Pai, Gourish, Moger, and Mahale 2018). A study by Bull, Hariri, Atkins, and Moran (2015) demonstrated that the advancement and progress of digital fabrication technologies such as desktop 3D printers provides new opportunities for students to utilize their ideas and concepts in learning the English language. In terms of education, the students can achieve new ideas and methods to acquire the language effectively in a 3D printing English language classroom. Moreover, the advent of 3D printing and advanced manufacturing offers students the opportunity to re-establish the dynamic interconnection among the historically related subjects.

A study conducted by Jasveer, and Jianbin (2018) outlined that there are five types of 3D printings broadly utilized these days which are Stereolithography (SLA), Fused Deposition Modelling (FDM), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM) and Digital Light Processing (DLP). SLA is widely used to create models, prototypes and patterns using laser based process. Next, FDM is popularly used for making models such as well as prototyping which builds a part layer by layer from bottom to the top. Another notable 3D printing technology is SLS. In this process, small tiny plastic particles, ceramics and glass are joined by heat from a high powered laser beam to form a solid. In the method of LOM, sheets of plastic or materials are laminated and fused together by high temperature and pressure then shaped to the required form with a computer-controlled laser or blade and the last method is DLP which uses conventional light as a remedy for photo polymer resin.

In terms of English language learning, Dimitrijevic, (2020) defined that 3D printing in English classroom facilitates language learning by assigning group activities to the students and inculcating the practice of collaborative learning, brainstorming, critical thinking, online research, shared document production and exchange of ideas using the online platform. 3D printing in an English language

classroom context plays a significant role by showing casting the information of the subject content within the computer screen into the real, physical world and the beauty of this progress now falls onto the hands of the students for inspection, analysis, and other processes that may benefit from the physical manipulation. Moreover, Shahrubudina, Lee, and Ramlana (2019) stated that 3D printing technology is truly innovative and has emerged as a versatile technology stage. It opens new opportunities and gives hope to many schools, teachers and students to look into possibilities of acquiring the skills of learning and utilizing 3D printing in an English Language Classroom. This movement can help them improve their commands in the English Language. It is worth noting that the purpose of this study is to review the literature on the utilization of 3D printing in the English language classroom.

This study adopts the Innovation Diffusion Theory (IDT) proposed by Rogers (2010). This theory has been widely applied for studying the adoption and diffusion of innovation through mastering the English language as it is reliable in examining the adoption and diffusion of a new technology in learning a language. It describes the process of learning a language through awareness, interest and intention of mastering the English language. The theory also proposes five characteristics or attributes of innovation which are relative advantage, compatibility, complexity, observability and trialability and this helps the learners' competence in comprehending the English language. This theory encourages teachers and learners to look into learning a language through creativity.

### **3D Printing Technology in Today's Education System**

The approach towards education has evolved as time goes by and the learning experience through online and digital platforms have become a crucial requirement for an interactive classroom teaching and learning. 3D printing utilization in modern education has served to enrich the learning experience in schools and education centers and it is becoming more advanced in terms of its usage in tertiary education institutions such as at the university and colleges. This also has made professional degrees easier in terms of its subject content delivery.

Hurkadli (2019) stated that today's classrooms with the infusion of 3D printing provides opportunities for teachers and students to discover how 3D printing can be utilized in a practical application. He further explained that due to its proven versatile nature of its application, 3D

printing now acts as a facilitator in imparting real world application and knowledge in education. Elrod (2016) stated that in China, 3D printer manufacturer Tiertime estimates that 90% of its domestic market share comes from school laboratories, which need desktop 3D printers so that students can scout for more information regarding their project work and experiments. Many of these educational spaces have already integrated additive manufacturing technology into their classrooms and curriculums. Hurkadli (2019) believes that one of the most remarkable applications of 3D printing in modern education is the 3D models of artwork for students in graphic designing. This success of 3D printing application in graphic art design has given the access to students in embarking on the pathway to acquire beneficial skills which can help them in their career advancement and digitalization.

Vickers (2017) carried out a study on overcoming the barriers to 3D printing in the classroom and she concluded that 3D printing technology in modern education has undeniably unleashed creativity and positive impact on education through increasing students' motivation and stimulating their curiosity. Moreover, she specified that as the students are becoming more familiar with the STEAM (Science, Technology, Engineering, Art, and Mathematics) and they are able to incorporate 3D printing skills in their learning. Gupta, Nesterenko, Paull (2019) mentioned that polishing 3D printing skills at school and university not only help students to see, hold, test and hone their ideas in the real world, but also gives them a massive jump start on this electrifying technology which will assuredly have influences on their future jobs and lives. By adding this experience, it helps students become familiar with 3D printers and its models which will aid them to apply their knowledge and skills when they are required to.

### 3D Printing in the Classroom

Woodruff, Checrallah, and Whalen (2021) stated that 3D printers are receiving a lot of interest in the educational space, and are frequently cited as a new catalyst for learning. Certainly, this revolutionary technology is helping teachers to make the students be more engaged in activities and not to depend fully on the textbooks. Wonjin, Jang, Harianto, So, Lee, Lee and Moon (2016) elaborated that as the importance of visual aids increases, textbooks are including more figures and images to help with students' understanding. In a study conducted by Zarei, & Al-Shboul (2013) also concluded that the students had positive perceptions towards employing the Internet as a

learning device, obtaining sufficient general knowledge of the Internet, and the learning was encouraged via integrating Internet in teaching. Therefore, students need to acquire the skills of 3D printing and learn how to implement it in English language classroom. By using 3D printing in the classroom, students and teachers can use the platform to discuss the information and activities which enhances the language learning process. When students are learning a certain language, they need to get access to all the reliable and useful resources in order to have a better view on how to perceive the language. 3D printing technologies such as the Maker Spaces and FabLabs help students learn the language on their own. Thus, educators are working towards figuring out how to effectively use 3D printers to enhance and adapt lessons (Peng, Yang, Gu, Amis & Cavicchi, 2019).

Roy and Brine (2017) mentioned that 3D printing pertaining to classroom facilitates language learning involves students in complex sets of activities such as collaborative learning, brainstorming, critical thinking, online research, shared document production, online exchange of ideas, physical handling of equipment such as 3D scanners, applications 3D printers, cartridges, concept mapping tools and understanding concepts of digital content management. With the implementation of Project-based CALL (Computer Assisted Language Learning) pedagogical approach, in the lines of what was suggested by Karpati (2009), students learn English language as they become co-developers, harness collective intelligence, link services and resources, get control over ever-emerging data sources, and use software that goes beyond a single device. In this case, technologies have the immense potential to get students involved in contextual framing of language in unique and impromptu project-related contexts. Roy (2017) further elaborated that such a project-based CALL approach is completely in tune with Web 2.0 technology and School 2.0 principles of collaborative, constructionist and connectivist learning paradigms, where an expandable community of learners creates knowledge and minimizes the role of instructors. In other words, learners co-design their learning trajectory, and create, and develop their learning contents on their own.

Since the education approach is gearing towards the Science Technology Engineering Mathematics (STEM) with the emphasis of language, therefore the usage of 3D printing in the classroom is highly recommended. Kwon (2017) pointed out that seeing the real world applications through the use of technology also motivates students to learn (Ching, Basham, & Planfetti, 2005). Thus, adding technology to any discipline can be an effective approach

to teaching by enhancing students' technical skills and allowing them to apply their skills to real-life.

In addition, Kwon (2017) concluded that 3D printing and 3D design software provide students with freedom to learn while exploring different pedagogical approaches. Students are able to succeed at creating 3D objects because they learn with their particular learning style (Lacey, 2010; Vanscoder, 2014). Students who use technology in order to learn English language are able to explore ideas that can assist them to write essays, improve speaking and reading skills and activities which allows them to link the ideas mentally and verbally in order to build representations. In addition, student-centered lessons and technology-integrated lessons help students think critically, figuring out comprehensive and brainy ideas to write, apply and engage in the learning process (Lacey, 2010).

Kwon (2017) believed that 3D Printing technology can also be used and implemented in classrooms to provide meaningful information for teachers and educators in various learning institutions. Student Response Systems (SRS) can be handed out to students to post answers anonymously to the teacher like answering and participating in online questions in Padlet. Digital online learning platform allows teachers to see what areas of the content students are struggling with in order to improve test scores by clearing up any confusion (Jones, 2000; Jones 2001; Karner & Bell, 2013). It also provides instant feedback, where teachers can adjust their teaching accordingly. Therefore, technology can improve teachers' competency and students' learning process when properly utilized in the class. In the language learning classroom context, Kwon (2017) further supported the idea that a teacher should use video clips and software tutorials to introduce 3D designing and printing. Students started exploring the language tutorials on how to write a good and comprehensive essay, summaries by using the Grammarly Software Program (GSP) before they started write the outline of their essay construction. Students not only received support from the teacher and classmates, but also learned on their own by watching the software tutorials and turning in over and over again. The teacher's role was to check if the students were on the right track and addressed any misconceptions to the class.

In fact, Shim and Lee (2019) analyzed the characteristics of design education for middle school students and developed 16 design educational sessions using 3D printing to determine how a multi-converging educational program is developed by targeting middle school students as design methods. In order to make sure that effectiveness

of the developed program is being examined in all aspects, indexes which were formed by two ways named common competence and design competence. These methods were constructed and were given to the actual middle students with a total of 16 session plans developed. After examining the effectiveness through pre and post evaluation, it was concluded that 3D printing brings positive impact as a program in multi-converging education for middle school students. The implementation of 3D printing as a service was offered by librarians. They discussed how the community college library managed 3D printing services to support class curriculum (Letnikova and Xu (2017).

Furthermore, Kwon (2017) provided an example in his 3D printing study that during the summer camp, the students who had finished their writing project presented their writing to the teacher in class by explaining the purpose of their writing together with the reasons why their writing were different this time as compared to the writing they presented earlier in their writing project without the application of 3D printing. On the last day of the camp, the students were asked to fill out the survey regarding their experience in using 3D printing in their writing. According to the results, they felt confident to utilize the 3D printing better and they became more interested in using it in their writing and real life skills in the future.

In conclusion, there are many advantages and benefits of 3D printing and its usage in the language learning classroom. Even though, there may be challenges towards the usage of 3D printing, yet it should not be an element of discouragement of using it. It is advisable for schools to adopt and adapt this 3D technology as it can bring a change towards the approach of the teaching and learning in this 21<sup>st</sup> century era. Song (2019) mentioned that despite the slumber uptake of 3D printing technologies in schools, thorough meaningful observations of the benefits and challenges involved in integrating these technologies into curricula could provide suggestions for further opportunities. Emphasizing on issues identified in implementation of 3D printing education, the implementation of digital fabrication education initiatives, including whether they have revolutionized teaching and learning in the K-12 context, and provides ideas for future development.

### **Advantages of Using 3D Printing in Language Learning and Teaching**

Since education is evolving in time with the usage of technology, therefore most educational institutions are

adapting and adopting 3D printing as a tool to make teaching and learning more appealing. Hossain, Zhumabekova, Paul and Kim (2020) highlighted that 3D printing is a rapidly popular technology and many people found it practical in its applications in various sectors. In addition to technical uses, the use of 3D printing is a supporting tool in education especially in English language classes. The benefits of using 3D printing include greater student involvement, the ability to visualize and better understand theoretical concepts, the integration of practical and theoretical skills. (Assante, Cennamo, and Placidi 2020).

Most educational institutions believe that infusing 3D printing into language learning classroom brings many advantages for students and teachers to engage in learning. Reid (2018) mentioned that 3D printing keeps students engaged during classroom lessons which promotes interactive learning and creates a rewarding environment for both parties, students and teachers. Besides, 3D printing also encourages creative and critical thinking during lessons in the classroom. Walia (2020) in her article believes that movements associated with art, such as holding and manipulating tools, equipment, and materials show that the students are doing their level best to solve the problems based on the activity given using their self-creativity and critical thinking skills.

Trust and Maloy (2017) conducted a study on the results of a survey asking teachers about the effect of 3D projects on students' learning. In their study, questions on the kinds of 3D projects were raised by the teachers while they were conducting their class projects with the students. Participants reported that their students developed a number of skills while working on 3D printing projects, including 3D modeling, creativity, technology literacy, problem-solving, self-directed learning, critical thinking, and perseverance. Through the class discussion the students identified the concepts that they needed to know in order to perform well in the tasks. They were enlightened by the idea of visual models of the spatial objects where they were required to imagine the tasks which could help them overcome the difficulties. Then, the pupils explained on the concept of the lesson, in which they could apply the knowledge and skills acquired in the task (Trust and Maloy (2017).

Verner and Merksamer (2017) supported that to be competent and holistic graduates, the students need to find solutions out of the problem using creativity and 3D printing helps to sharpen their creativity and analysis skills in language learning. Knill and Slavkovsky (2013) stated that 3D printing technology can aid to visualize the linkage

of ideas and place the ideas on a paper. In addition, 3D printing can help illustrate and visualize concepts and language synthesis among the students. Educators in ancient Greece were being informed that, models allow to bring language learning closer and reached out to the public. Realization towards such tools is more accessible than ever after the breakthrough of the new 3D printing design.

Furthermore, Zhang, Wu, and Zhang (2016) highlighted that 3D printing gives students the opportunity to discover about iterative development. They have also stated that if schools have access to 3D printing, students can learn and acquire the skills of creating software, landscape, and managing projects in their fields. In fact, 3D printing is an ideal blueprint for students to learn language skills and later on, apply them not only in finding jobs but also, in creating them. In short, there are many advantages that 3D printing has brought forth in the education in general and specifically in language learning field. Students need to realize the potential of 3D printing, do their level best to grasp the 3D printing knowledge and soar towards a bright future.

Novak (2019) stated that since the rapid integration of 3D printing were provided in schools and universities and made it as the main preference, educators should equip themselves with up skilling new skills, class structures, and procedures. This is where many teachers with non-technical expertise may find it difficult to master and grasp the skills of using 3D printing in the classroom. 3D printing and computer-aided design training traditionally require extended instruction and experience, which are unlikely to be practical for school teachers. (Chameettachal, Yeleswarapu, Sasikumar, Shukla, Hibare, Bera, and Pati 2019). Ford and Minshall (2019) believed that 3D printing technology in industry is growing as new applications are found to take advantage of their functionalities. Therefore, the usage of 3D printing is crucial when it comes to language teaching. There is a high demand that language teachers need to master and utilize the 3D printing in order to make the teaching and learning environment more creative and interesting. With the infusion of the 3D printing technology in language teaching context, it would be convenient to deliver effective teaching approaches and engage the students in English language lessons.

Historically, these 3D printing tools have been costly and difficult to access; however, recent advancements in technological design have been accompanied by decreasing prices (Hanson, Langdon, Mendrin, Peters, Ramos, Lent 2020). For instance, through creating group activities

in the classroom, teachers or instructors can require the students to come up with a digital English language learning mind map to play online language games and answer online questions as a feasible way to help them in learning and comprehending the subject. In this case, the students will be able to get involved in more critical thinking activities which meets the goal of a successful teaching.

Additionally, Novak (2019) explained that for 3D printing in particular, universities are suggested to be vital partners and work hand in hand with the teachers to encourage ongoing learning. This may lead them to act as hubs through which local schools may leverage knowledge and equipment free from many of the biases in existing 3D printing forums and education websites. Ullah, Kubo and Harib (2020) encourage educators and students to sharpen their knowledge and skills of 3D printing as it may be useful in upgrading the standard of education within schools in the near future. This presents the structure of a Professional Development (PD) program that should be emphasized in universities and schools especially for K-12 school teachers, can be refined with the aim of establishing a strong foundation in both theory and practice, driven by a "learning by making" philosophy. (Loy, 2014). It is worth mentioning that 3D printing workshops have been found to be rich in collaboration, with teachers across disciplines and schools connecting and sharing new strategies to implement 3D printing into curricula, access equipment and funding, and create more enriching cross-disciplinary projects that suggest new possibilities for the future of education. It is also encouraged for teachers' assistants who are experienced in building 3D printers to lend a helping hand to the present teachers in journeying this process.

According to Irwin, Douglas, Oppliger, Pearce and Anzalone (2015) "in addition to building the printers, the teachers are given introductions for the use of the completely free and open-source software tool chain used to design and print models". Hands-on 3D printing activities can be a practice to encourage new flipped classroom for language teaching strategies that challenge conventional teaching models, so that training can be effective for encouraging a bottom-up engagement with 3D printing. In addition, during the recent COVID-19 pandemic, the whole world witnessed that 3D printing and social media were used to conduct online teaching and learning (Vordos, Gkika, Maliaris, Tilkeridis, Antoniou, Bandekas, and Mitropoulos 2020). Drakoulaki (2017) argued that nowadays technology is an important part of the students' lives and they have to be adaptive and be fast learners as technology requires them not to wait to acquire knowledge within the limits of the

university campus merely, but beyond that which is being independent learners. In line with the above scholars, Abbasi Kasani, Shams Mourkani, Seraji, Rezaeizadeh, and Abedi (2020) also proved that technology plays a significant role and e-learning systems facilitates the students' learning process. As one of the technological tools, "3D printing provides a wide spectrum of language devices and mind mapping. This versatile technology is suited to address problems in writing and brainstorming ideas" (Choong, Tan, Patel, Choong, Chen, Low, and Chua 2020).

3D printing in this modern era has made learning easier for the students to tap the potential and make use of the search engine provided to scout and discover more information and knowledge. In other words, 3D printing has contributed to active learning. Active learning means students need to look for information and present their findings in group works and class activities. When it comes to collaborative assignments, students need to exchange their information and though with their classmates. When students exchange their ideas, active learning takes place and students will be able to learn more based on their own efforts and the amount of reading. Drakoulaki (2017) provided an evidence in his study that 3D printing can aid the mental rotation ability in 46 primary school children at the age of 10 as this is the age with increasing development of the rotation ability. The results proven were particularly interesting as the 3D printing courses aided noticeably the mental rotation ability of the students.

### **Challenges of Using 3D Printing in Language Learning**

3D printing has brought forth many changes and approaches in language learning. Even though there are many benefits of 3D printing in language learning, challenges and obstacles should not be neglected. Firstly, many schools are willing to adapt 3D printing technology in their education system, however, somehow they found it difficult because it is expensive and they cannot afford it as Nandi, Caspi, Grossman, and Tatlock (2017) explained that 3D printing is important, however the school or the learning institution must have adequate budget to purchase it. Besides, another challenge is that 3D printed object quality depends on its composition of additive materials, manufacturing process, type of 3D printers used, speed of the printer, and the volume of the object printed. This will determine the performance of 3D printing in the language classroom (Pandian and Belavek, 2016). 3D printing has revolutionized the society from providing language and linguistics advances to scalable production of everything from product parts to buildings (Fang and Kumar 2019).

Next, teachers and educators who lack skills and experience in using 3D printing in language teaching and learning may face challenges in the integration of 3D printing in classroom. If they are not proficient in using the 3D printing technology in the language learning classroom, they might struggle in teaching the students how to utilize the 3D printing. It is worth noting that some parents are not confident about the utilization of 3D printing in the language learning process takes place at home. For instance, online learning during the Movement Control Order (MCO), which is happening now due to COVID-19 pandemic can be challenging to the parents. When 3D printing technology is used in online English teaching and learning, some parents may not be able to assist their children in learning if it is necessary. Parents and guardians find that teaching and learning a language using 3D printing technology is ineffective and it does not meet the requirements of an active and effective learning (López, 2010).

Kumar, Pandey, and Wimpenny (2018) highlighted that there are two main issues of 3D printing which are the technical problems and the controversies. They commented that as 3D printing is getting more widespread, the issue of its quality is always being questioned. A call for an efficient quality displayed by the 3D printing is crucial in order to ensure that the teaching and learning of a language is smoothly delivered. In fact, the results of a study by Gürer, Tekinarslan, and Gönültaş (2019) illustrated the scale and factors displayed a satisfactory level in the usage of 3D printing in education, ranging from 0.68 to 0.94. The findings of this study also portrayed that the scale was valid and reliable, and could be used by the researchers who are interested in technology integration in teaching and learning environments.

Furthermore, Ford and Minshall (2016) conducted a study on two Greek schools whereby the schools had the 3D printing technology incorporated in their English language education system. They identified five challenges that the school faced in using 3D printing which are as follows: expanding the range of physical media available for printing, incorporating ideas derived from “pick-and-place” mechanisms into 3D printing, exploring methods for creating portable and ubiquitous printing devices, creating tools for hand-customization and finishing of tangible printed objects and devising software techniques for specifying, altering, and combining 3D elements in the context of printing. Gaddis (2020) developed a survey to collect data from the students in University of Colorado. He explored the students’ perceptions on how technology influenced their learning, their preferences for specific technology tools, and their academic

performance progress. Ninety-three percent of student respondents indicated that technology enhanced their learning. Alignment between the faculty use and student preference for technology tools showed that students are actively engaged in the technology resources used by faculty to enhance learning.

To sum up, 3D printing has its numerous advantages, however, it is also crucial to take into consideration its challenges and obstacles. As a matter of fact, although it is useful to implement 3D printing in language learning classroom, in terms of its challenges, educators and learning institutions need to find ways on how to overcome those challenges and administer 3D printing technology in the language learning classroom.

### Conclusion

In brief, 3D printing technology has played an important role in many sectors and aspects of human lives especially in the education context. Learning and acquiring English language through 3D printing in the classroom has brought forth many changes and it has reversed the approaches and perspectives of traditional English language learning. Students, teachers, education practitioners, and learning institutions have benefited from the usage of this modernized technology. Teachers and educators found that 3D printing is appealing and meets the demands of an active, creative, and friendly language teaching and learning environment. Students are able to scout information and knowledge on their own by using 3D printing which helps them learn the language at a fast pace. Even though there are many challenges and limitations, learning institutions should embrace the hurdles and find the appropriate solution to overcome the challenges.

Most of the above studies mainly focused on the development of 3D printing and its benefits towards industrialization, field of arts and teaching and learning through STEM Education. However, there is a gap in the literature on the significance of 3D printing in teaching and learning the English language and how it acts as an ideal tool in learning the language. Therefore, this study intended to highlight the significance of 3D printing and how teachers and students can utilize it as a platform to make teaching and learning more creative and approachable.

Besides, this study highlighted the challenges of 3D printing in teaching and learning the English language and how educationist and learning institutions can overcome this problem in using this technology which was

not highlighted by previous studies. Even though, there are challenges towards integrating 3D printing in teaching and learning English language, educationalist should look into ways on how to address and overcome the challenges faced by students and teachers. This study provided comprehensive guidelines on how to address and overcome such challenges.

Considering COVID-19 pandemic, for example, in terms of education, the whole world had no choice but to adapt and adjust with online teaching and learning. Waseem, Kazmi, and Qureshi (2017) analyzed the traditional education system of Pakistan in comparison to international modern education system with 3D printing technology. Their study is significant as it brings many benefits for educationist, understudies and individual working in the field of prototype development and customization who wish to see how the field has developed and evolved. Their study identified key contribution of 3D printing technology as a factor in state development. Further research can be carried out to investigate the students' and teachers' perspectives on 3D printing in teaching and learning English language with a larger sample size to achieve much more feedback on their experience in utilizing 3D printing. Goh, Sing, Yeong (2020) stated that the reliability of 3D printed parts has been the focus of the researchers to examine the reliability and validity of this tool in language learning context. Each learning institution is highly recommend to have 3D printing technology available in their classrooms so that a different learning experience can be achieved when it comes to English language teaching and learning.

### Competing Interest Statement

All the authors have read and approved the manuscript and take full responsibility for its contents. No potential conflict of interest was reported by the authors.

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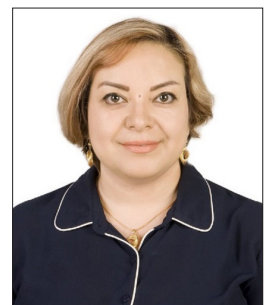
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