Use of 3D Printing Media for Learning Tooth Brushing Skills in Early Childhood

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Abstract: The rate of tooth decay in early childhood is still very high. Children need appropriate learning media to be able to improve their tooth brushing skills. **Objective**: To analyze the effectiveness of using IA teeth and mouth 3D printing learning media in improving the tooth brushing skills of children aged 5–6 years. **Method**: One-Group Pretest-Posttest Design Pre-Experiment. The total sampling of respondents from children aged 5–6 years was 34 people. The assessment instrument uses an observation sheet with 10 indicators. Data analysis used the Kolmogorov-Smirnov data normality test and the mean difference test with the Wilcoxon signed rank test. **Results**: There was an increase in the average tooth brushing skill after the intervention using IA teeth and mouth 3D printing learning media, especially regarding tooth brushing techniques. The average pretest is 20.68, and posttest is 37.58. The results of the mean difference test showed a significant increase in skills (p = 0.000). **Conclusions:** IA teeth and mouth 3D printing learning media are effective in improving the tooth brushing skills of children aged 5–6 years. Impact: The effectiveness of IA teeth and mouth 3D printing learning media in facilitating the learning of tooth brushing skills is known.

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A. INTRODUCTION

The learning media is one of the elements in the learning process that plays an important role as an intermediary, bringing information from the teacher to the student with the aim of facilitating learning, so that the student has knowledge and skills in accordance with the learning objectives. The learning media chosen to facilitate learning is expected to be able to make it easier for the student to understand the content learned by making the media as similar as possible to reality. Teaching to brush teeth is one of the lessons contained in the curriculum of early childhood education as part of the practice of clean and healthy life behavior. The learning to maintain hygiene is given with the aim that the child has a positive attitude and participate actively in the maintenance of hygiene, health and self-care independently. Early-age children, especially those who have entered the age of five or six, begin to be trained for self-reliance as a preparation for entering primary school education (Kemendikbudristek, 2022). In addition to training for self-sufficiency, learning to brush teeth also aims to prevent the occurrence of tooth damage that is currently very high in five-year-olds, which is an average of 8.1 based on Basic Health Research (Kemenkes, 2018).

Based on the results of the preliminary study by conducting interviews with the head of the school and teachers of early childhood education as well as observations of the implementation of ongoing learning to brush teeth, that one of the problems encountered in the learning of brushing teeth is not having a learning medium to explain the material and provide examples of the correct toothbrushing technique to the pupils. According to Richey et al. (2011), one of the characteristics of learning media is how close the media is able to facilitate the presentation of content that matches reality. Media in real form is suitable for the bottom learning experience of Dale's Cone Experience, which means it's perfect for learners who study subjects and have little practical experience in everyday life. Real things have the potential to explain what is obscure and stimulate imagination (Heinich et al., 2002). Early childhood is a pupil who still has limited experience and ability to understand abstract things.

Teaching to brush teeth in early childhood has the aim of improving independence and preventing the spread of tooth damage, so learning should be facilitated with media that corresponds to the characteristics of early children, i.e., through a real 3-dimensional medium. 3D printing is an additive manufacturing process that can perform printing by adding layer-by-layer materials and can be used to help the learning process (Simpson & Taliafferro, 2021). Objects to be printed are created in file form and exported into 3D objects in a series of layers (Kalaskar, 2017). 3D printing technology allows for a replica quality according to the photographic result, printing accurately except for haptic quality, and is capable of reproducing in unlimited quantities for use by pupils in large quantities (McMenamin et al., 2021). In connection with this, IA teeth and mouth 3D printing learning media have been developed for use in the learning of brushing teeth for children aged 5–6 years. This research aims to analyze the effectiveness of using IA teeth and mouth 3D printing learning media in improving the tooth brushing skills of children aged 5–6 years.

B. METHOD

Research methods using the pre-experimental One Group Pretest-Posttest Design. Respondents used a total sampling of students aged 5 to 6, who were 34 people, but who were able to follow the entire phase of the study only 31 respondents. The research was carried out at Bina Harapan III, Kelurahan Gandul, Cinere district, Depok City, West Java, in January–February 2024. The research instrument used an observation sheet with 10 indicators of the brushing stage with a score range of 0-4. Assessment is carried out from the preparation stage of the toothbrushing equipment and materials to the implementation and re-storage of the tool and tooth brushing materials to their original location. The pretest was done by doing the observation of brushing learning that is ongoing in the school, and the posttest was done after the intervention of learning using IA teeth and mouth 3D printing learning mediums. The medium of IA teeth and mouth is a combination of jaw that has been circulated in the market, modified by adding cheeks and lips, and printed with 3D printing techniques using Fused Deposition Modelling (FDM) printing techniques using Thermoplastic Polyurethane material. Experts in learning media have examined the developed media and determined that it is suitable for use with young children.

Figure 1. Learning media of IA teeth and mouths developed with 3D printing

The intervention is carried out through 3 stages: presentation, exercise, and self-practice, which are done in 9 meetings, each lasting 1 hour of learning. The presentation stage is to convey the purpose of learning and the stages of brushing teeth; the training stage is for the students to prepare the tools and materials to brush their teeth independently; the practice technique of brushing teeth using the model of IA teeth and mouth 3D printing; and the practice of washing and storing tools and materials on the storage shelf. Each stage of the student is accompanied by a teacher, who gives reinforcement and feedback. The data analysis is done by performing differential tests of the average value of the pre-test and post-test. Before performing the difference test, first perform the normality test of the data using Kolmogorov-Smirnov. The data is distributed abnormally, and then the difference testing is performed using the non-parametric statistical test of the Wilcoxon Sign Test.

C.   RESULTS AND DISCUSSION
1.   Results

Based on the results of the study with 10 indicators of the stage of brushing the teeth, that is, the preparation stage, the assessment carried out related to how the child can prepare a toothbrush, fill a glass of water, and prepare toothpaste on a brush. The observed stage of execution is the ability to brush teeth on the surface of the cheeks, lips, occlusal, and teeth facing the palate and tongue, anterior and posterior. The completion stage is mouth-rinsing, washing, and storing tools and materials back on the provided shelves. Based on the results of the pretest and posttest observations, the following results were obtained:

Table 1. Results of pretest and posttest skills
for brushing teeth using 3D printing learning media

Tooth brushing skills	N	Mean	Minimal	Maximal
Pre-test	31	20,68	15	24
Post-test	31	37,58	30	40

Based on the data in Table 1, the pre-test and post-test averages increased by 16.9. The biggest improvement has been in the performance assessment indicators of brushing the teeth, especially on the palate-facing part of the tooth and on the front and back tongue. This area of the tooth received no cleaning at all during the pre-test phase, but after intervention, the respondents gave it a brushing. Before a mean difference test is performed, a normality test is

first performed to determine whether the data obtained is normally distributed or not using the Kolmogorov-Smirnov test. The test results are as follows:

Table 2. Data normality test with Kolmogorov-Smirnov

Tooth brushing skills	Statistic	df	Sig
Pre-test	0,215	31	0,001
Post-test	0,291	31	0,000

Based on Table 2 the results of the data normality test on the pre-test and post-test values obtained a significance value of p ≤ 0.05, and it can be concluded that the data is not normally distributed. If the data is not distributed normally, then the next two mean difference tests are performed using the Wilcoxon Sign Test non-parametric statistic (Hastono, 2017). The test results showed the following results:

Table 3. Mean difference test results with the Wilcoxon Sign Test

Tooth brushing skills	Negative Ranks	Positive Ranks	Mean Rank	Sum of Rank	Sig
Posttest-Pretest	0	31	16,00	496,00	0,000

The data in Table 3 showed that all respondents experienced an improvement in their brushing skills after the intervention, with a p-value significance of 0.000. With a p-value of ≤ 0.05, it can be concluded that there was a significant improvement in their tooth brushing skills after learning to brush their teeth using the learning medium of IA teeth and mouth 3D printing in children aged 5–6 years.

2. Discussion

Learning to brush teeth to enhance the child's skills to be able to clean the rest of the food in the mouth optimally requires the ability to brush the teeth correctly and in accordance with the surface of the tooth being brushed. In order to achieve such learning objectives, appropriate learning media are needed to facilitate the understanding and fine motor training of children in brushing their teeth. 3D printing technology is an innovation that can be used to print a variety of learning media using different materials quickly and accurately according to learning needs. With the latest advances in technology, the 3D printing material used for printing the learning media replica of the anatomy of the human body has become more and more similar to the original. According to research by Jaksa et al. (2021), who created 3D printers using multi-material materials like silicon and thermoplastic rubber to mimic the mechanical properties of various soft tissues in the human body.

IA teeth and mouth learning media are needed to practice proper toothbrushing techniques regarding the direction and position of the toothbrush in the mouth. Based on the research results, an increase in the average value of tooth brushing skills occurred in all child respondents aged 5–6 years after the intervention. This is probably because they have not been

informed about the details of the tooth surfaces that need to be brushed, and no one has guided them specifically about tooth brushing techniques or provided encouragement and feedback regarding their tooth brushing habits. Learning to brush teeth at school is carried out in a structured manner, guided by teachers, using media that can be held, exercises, and then practice on their teeth, which causes children to be enthusiastic and able to carry out the steps and techniques for brushing teeth taught. This increase in children's ability to brush their teeth is in accordance with the opinion of Ozgul et al. (2019), which states that children aged 5 years will likely be able to clean their teeth well when given detailed information, guidance, and supervision, because the results of their research found that there was no significant difference in the teeth cleaned by parents and children aged 5-7 years.

Exercises or simulations using IA teeth and mouth 3D-printed learning media before the practice of brushing their own teeth will improve a child's readiness and confidence. It helps the child improve the knowledge and fine motor skills of their fingers in holding, moving, and changing the position of the toothbrush on different tooth surfaces so that the remaining food can be cleaned on the entire tooth surface. This is in line with a study by Towers et al. (2022) that found that the use of 3D printing media as a learning medium before conducting direct treatment to the patient can improve the self-confidence and readiness of the student. In addition, it can also reduce stress or anxiety when the first time to do treatment for the patient (Sinha et al., 2021). 3D printing models that are designed to be similar to the original based on the results of student satisfaction surveys state that the model is an effective tool for training, practice, and assisting in technical movements (Pouhaër et al., 2022).

The IA teeth and mouth 3D-printed media are very similar to the original condition, making it easy for students to recognise and adapt to adjust their movements when brushing their own teeth. The surface of the tooth that is not cleansed at all at the time of the pretest is the surface of a tooth facing the palate and the surface that faces the tongue. When all respondents tried to brush their teeth in the posttest, some were already capable of brushing the teeth very well, but most still needed improvement through exercise and habituation, especially the back, while most of the front were already able to apply the brush technique properly. This is in line with a study conducted by Eigbobo & Arigbede (2020), which stated that the surface of the tooth facing the tongue is the most rarely cleaned surface when brushing the teeth and only a small fraction of elementary schoolchildren brush the entire surface of their teeth and tongue (14.5%).

In addition to learning media, things that also play a significant role in improving the respondent's toothbrushing ability are structured, applied learning strategies, guidance, and feedback, accompanied by learning modules and flipchart media to explain and organise the learning process in a planned and directed manner. In relation to the purpose of learning to brush teeth, which is to improve skills, the learning strategy used is a modification of the Direct Instruction strategy, which, according to Joyce et al. (2015), consists of five phases: orientation, presentation, structured practice, guided practice, and independent practice. To train complex skills in learners by breaking learning into smaller, more structured ones, teachers provide examples, train, and guide learners to be able to learn new skills independently. Direct instruction, according to Kilbane & Milman (2014), is teacher-led learning to improve the

ability to use new procedures through improved understanding and developing independence gradually.

The self-practice phase is done at school, and the assignment is done at home. In the self-practice phase at home, the technique of brushing teeth using the IA teeth and mouth media is recorded through video and sent to parents so that parents can know the lessons their children have learned in school, watch, guide, and provide encouragement to be able to brush their teeth independently. Successful learning and the involvement of parents in preschool activities are important because, according to (Rayhan, 2022), home learning guidance, parental time, home environment, and preschool activities are important parts that affect the development status of early childhood.

In addition to facilitating learning with learning media capable of making situations as close to reality as possible, training 5–6-year-olds to perform steps and techniques to brush their teeth correctly requires structured and repetitive practice. Brushing teeth is a fine motor skill that involves smaller muscles, requires precision of movement, and tends to be manipulative (Coker, 2018). Preschool children with structured physical activity education have significantly improved coordination among movement members (Ruiz-Esteban et al., 2020). This condition is also in line with the Practical Life Practice in Early Childhood program developed by Montessori (Bush & Sciaraffa, 2019), one of whose activities is self-care by brushing teeth. Through full attention and repetition, children are able to complete tasks well, accurately, smoothly, and systematically, as well as develop cognitive and fine motor skills, improve concentration, self-effectiveness and independence.

Through repetitive and structured exercises, children are expected to have the skills of cleaning their teeth to prevent damage to their milk teeth and to care for their permanent teeth that are starting to grow. The period of learning to brush teeth at school will only last for a certain period of time. The support and involvement of parents in the success of this learning to brush teeth is crucial in ensuring that children continue to pursue good habits in keeping their teeth and mouths healthy at home. It is consistent with the findings of Varshney et al. (2020) that parental involvement is an integral part of the success of learning programmes in early childhood. Repetitive and structured exercises, children are expected to have the skills of cleaning their teeth to prevent damage to their milk teeth and to care for their permanent teeth that are starting to grow. The period of learning to brush teeth at school will only last for a certain period of time. The support and involvement of parents in the success of this learning to brush teeth is crucial in ensuring that children continue to pursue good habits in keeping their teeth and mouths healthy at home. It is consistent with the findings of Varshney et al. (2020) that parental involvement is an integral part of the success of learning programmes in early childhood.

Parents' awareness of the importance of early childhood dental and oral health needs to be increased, so that support until the development of good habits in the behavior of brushing teeth in children is formed. Having healthy teeth will help a child grow and develop optimally. This is in line with the opinion of Benjamin (2018) that improving child oral health is important, not only for preventing pain but also for having a major impact on school performance, child self-esteem, and long-term oral health. This skill of brushing teeth will be brought to adulthood because training a child to apply good habits to keep his teeth healthy

is an investment in order to prevent their teeth from being damaged in the future. The implications of this research are that the effectiveness of the learning media of IA teeth and mouth using 3D printing technology in facilitating learning to brush teeth in children aged 5–6 years is known. The limitations of this research were that the sampling was not carried out randomly and did not have a control group.

D. CONCLUSIONS AND SUGGESTIONS

The use of IA teeth and mouth 3D printing learning medium is effective in significantly (p value = 0.000) improving tooth brushing skills in children aged 5–6 years. There was an increase in tooth brushing skills in all respondents after the intervention, especially regarding tooth brushing techniques. Further researchers to develop other learning media by using 3D printing technology, in particular for education, promoting improved dental health in the community. Early childhood school teachers enhance cooperation and build positive relationships with parents so that the learning of toothbrushing skills developed and applied in schools is consistently also implemented at home.

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