

# Effect of game based education in extension of oral health knowledge among 10–12-year-old school children – an interventional study

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## Abstract

**Background:** Dental Jumanji is a self-designed game where the participants have to roll dice demonstrate the task assigned to them on the game board. The aim and objective of the study was to assess and evaluate the additional effect of the Dental Jumanji game along with conventional lectures in the improvement of oral health knowledge among 10–12 years old school children.

**Methods:** This was a school setting and experimental study. A sample of 120 school participants aged 10 to 12 years were randomly assigned to two groups. A self -designed assessment form was used, and assessment was done at baseline, after conventional lecture alone and with Dental Jumanji and after three months follow-up in both groups. The missing data during follow-up was managed using the multiple imputation model. Comparison between groups was analyzed using the Mann-Whitney U test and within group comparison was done using Friedman's test followed by post-hoc Mann-Whitney U test.

**Results:** The comparison between groups showed statistical significant difference between the Lecture and Lecture+ Game group in post-test and 3-month follow-up with mean values of  $7.4 \pm 2.5$  and  $8.8 \pm 1.8$  post test,  $6.9 \pm 2.3$  and  $8.7 \pm 1.8$  at 3-month follow-up respectively. Intragroup comparison shows a significant increase in the mean values from baseline to post-test, and a slight decrease in the 3-month follow-up in both groups. Post hoc comparison in both groups showed that in each group the baseline, was significantly different from the post-test and 3-month follow-up ( $P < 0.05$ ), but the difference between the post-test and follow-up was not significant.

**Conclusion:** Oral health knowledge increased using the Dental Jumanji game in combination with conventional lecture. Dental Jumanji can be used as a positive reinforcement tool during oral health education.

**Keywords:** Oral health education, Dental Jumanji game, Multiple imputation model

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## Introduction

Oral health is an important component of general wellbeing and plays a crucial role in children health.<sup>1</sup> Dental caries is prone to increase by high consumption of sugars, such as monosaccharides and disaccharides. Fermentable sugars, which are sticky in form, increase the rate of dental caries, especially among the 10–12 age group as they are frequently exposed to sweetened food like chocolates, beverages, and junk foods.<sup>2,3</sup> This points to the importance of maintaining oral hygiene by increasing oral health knowledge through dental health education.<sup>4</sup>

School is the place where many age groups, from different locations in the city attend the classes. Many schools' that organize oral health programs conduct conventional lectures where only a small amount of knowledge is gained; thus, health programs should be

more interesting and understandable to improve children' knowledge and achieve better results.<sup>5</sup> Even though conventional lectures have an impact in upgrading the knowledge among school children the results are considered to be short-term as they do not lead to long term retention of knowledge. Hence, an additional mode of learning is necessary to enhance the outcomes. Newer way of educational teaching could be a game-based teaching, which can have a double effect of providing education and strengthening children's learning by a self-directed and entertaining format.<sup>6</sup>

Dental Jumanji is a self-designed game where students have to demonstrate the task assigned to them by rolling dices. It has been designed as a game-based dental health education tool. Dental Jumanji has been designed in both English and the local language (Tamil) for the betterment of education. It consists of a game board, user manual,



coins (pieces) and dices. The Dental Jumanji game board is 30x30 cm in size with 20 numbered squares starting from the left lower corner (Figure 1). This game board consists of 20 questions regarding the knowledge of teeth and their functions, general and oral health, and preventive procedures. The user manual contains instructions for the gamer along with the answers to the questions in the form of text or pictorial representations with explanations.

As there is no literature on the effect of Dental Jumanji, the aim and objective of the current study was to assess and evaluate the additional effect of Dental Jumanji when played alongside conventional lectures on the increase of oral health knowledge among 10–12 years school going children.

**Methods**

This was a pilot interventional experimental study. The present article follows CONSORT Guidelines. The protocol of this study was reviewed and approval was obtained by the Institutional Ethical Committee, code No. KIDS/IEC/2022/II/008, of the Karpaga Vinayaga Institute of Dental Sciences, Madhuranthagam and its in accordance with the Helsinki Declaration (1975), updated in 2013. Written informed and proxy consent were taken from the parents and teachers of all the respective participating school children prior to the study. The study was conducted in Maduranthagam school, Chengalpattu district, Tamil Nadu. School students aged 10–12 year were included. Sample size calculation was done using G Power software (version 3.1.9.4.) Heinrich Heine Universität, Düsseldorf, Germany, with F -test, repeated measures ANOVA within factors, with fixed

effect size of 0.25,  $\alpha$  error prob. 0.05, and power of the study  $(1-\beta)=0.80$ . A total of 120 children aged 10–12 years studying in the 6th and 7th standard grades were included in the study with a 1:1 ratio between boys and girls. Participants who were under special care, had systemic disease, or did not given informed consent were excluded. The selected subjects were taken to a separate hall or Dental Jumanji game after conventional lecture.

**Assessment form and validation**

The assessment form was designed in both English and the local language (Tamil) and the translation was checked by back translation method. The assessment form was tested for content validity by two public health dentists, two teachers, and a layman. The assessment form was assessed for relevance, simplicity, clarity, and ambiguity. Content The content validity index of the assessment form for relevance was 0.91, and the clarity, simplicity, and ambiguity were 0.84, 0.90, and 0.82, respectively. All the components had a CVI score more than 0.75, so the form was considered to be valid.<sup>7</sup> The assessment form was pilot tested and checked for internal consistency and reliability among 10 subjects other than the study subjects by test re-test method with 24 hours interval. The Cronbach’s alpha correlation<sup>8</sup> coefficient value was 0.865. The assessment form contained a space for students to write their demographic data and also included questions to test knowledge about teeth, the different types of teeth, oral hygiene, and healthy practices and also pictorial questions.

The baseline data of knowledge was collected. The school children were randomly allocated to the two groups using computer-generated randomization software.<sup>9</sup> The



Figure 1. Game Board Dental Jumanji

subjects were divided into Group I- conventional lecture only, and Group II- conventional lecture followed by game, with 60 subjects in each group (Figure 2).

Conventional lecture was delivered to both groups I and II using PowerPoint presentation by a trained person. In group II, learning was reinforced using the Dental Jumanji game, in which all the subjects were given the opportunity to participate. The Dental Jumanji game board (Figure 1) starts with square number 1 and goes up to 20. The subjects are instructed to read and demonstrate the task assigned in the square they move to by rolling the dice. The game was monitored by a coordinator, and the first subject to finish the game with comprehending demonstration with correct answer was given a token of appreciation and all participants received post-test assessment form.

After three months, the participants were reassessed using the same assessment form in both the groups. There were missing data in both the groups (absentees). Three missing data were found during the follow-up, which was managed using the multiple imputation model using the mean value of the gaming group.<sup>10</sup>

The data were compiled and tabulated in Microsoft Excel and subjected to statistical analysis using SPSS software, IBM Corp Armonk, New York (Version 22). Normality was checked using the Kolmogorov–Smirnov test and Shapiro–Wilk. The data distribution contained skewness and normality was not detected. Therefore, non-parametric analysis was used. Comparison between groups was done using the Mann–Whitney U test. Within group comparison was analyzed using Friedman’s test and post hoc Mann–Whitney U test, with *P* values < 0.05

were considered as significant.

### Results

The comparison between the mean values of group I (Lecture) and group II (Lecture+Game) at baseline, post-test, and 3-month follow-up. At baseline, there was no statistically significant difference between the groups with mean values of  $3.8 \pm 1.2$  and  $3.6 \pm 1.2$ , respectively (Table 1). Statistical significance was found in the mean scores between group I and group II, with mean values of  $7.4 \pm 2.5$  and  $8.8 \pm 1.8$ , respectively at post-test, with an increased mean score in group II. Similarly, at the 3-month follow-up, significant difference in mean value between group I and group II, with mean values of  $6.9 \pm 2.3$  and  $8.7 \pm 1.8$ , respectively, where group II showed an increase mean value compared to group I. The effect size (Cohen’s) was found to be 0.64 between groups I and group II at post-test and 0.85 at third month follow-up.

Table 2 and Graph 1 shows the mean comparison within groups at baseline, post-test, and third month follow-up in the Lecture and Lecture+Game groups. Both Lecture and Lecture cum + Game groups showed statistical significance in all time intervals i.e., at baseline, post-test, and third month follow-up.

The post hoc comparison within groups at different time intervals in both Lecture and Lecture + Game groups, showed that the mean value significantly increased from baseline to post test and to third month follow-up, with no significant change from post-test to 3-month follow-up in Group I (Lecture). (Table 3). Similarly, the mean score significantly increased from baseline to post-test and third month follow up where there was no significant

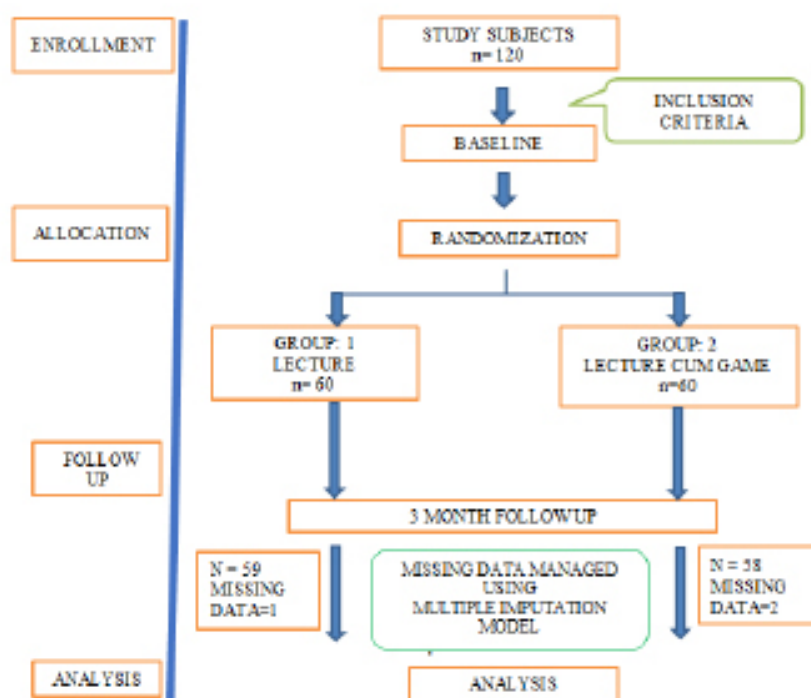


Figure 2. Consort flow chart of study design

**Table 1.** Comparison between lecture and lecture with gaming pattern at baseline, post-test and 3 months follow up using Mann–Whitney U test

	Group	Mean	SD	Mean Rank	Z value	P value
Baseline	Group 1	3.80	1.27	61.05	-0.179	0.858
	Group 2	3.6	1.22	59.95		
Post Test	Group 1	7.47	2.52	49.35	-3.554	0.001**
	Group 2	8.88	1.80	71.65		
Follow up	Group 1	6.94	2.37	47.47	-4.145	0.001**
	Group 2	8.76	1.84	73.53		

Group 1: Lecture; Group 2: Lecture cum Gaming

\*P value&lt;0.05, statistically significant; \*\*P value&lt;0.001, Highly significant.

**Table 2.** Comparison within group at different time intervals using Friedman test

Group	Time interval	Mean rank	Chi-square	P value
Group 1	Baseline	1.26	71.2	0.001**
	Post test Score	2.58		
	3 month Follow up	2.16		
Group 2	Baseline	1.03	111.2	0.001**
	Post test Score	2.53		
	3 month Follow up	2.43		

\*\*P value&lt;0.001, Highly significant.

change from post-test to third month follow up in group II (Lecture + Game).

## Discussion

The present study shows significant increase in mean values among subjects who both attended the lecture and played the game compared to subjects who attended only the conventional lecture in both post-test and the follow-up after three months. When comparing within the groups, both in group I and group II a significant rise in scores at post-test with a slight decline in the mean values in group I, this indicates that there is less retention of knowledge in learning with only conventional lectures. The outlier (Graph 1) in the Lecture + Game Group has been reduced in the post-test, indicating that there is an additional impact on knowledge in those who scored comparatively less in group I, and there was a similar decrease in the outlier in the follow-up too. Therefore, dental health education accompanied by game acts as an additional positive reinforcement tool and an ideal method to attract the back benchers to the topic of interest.

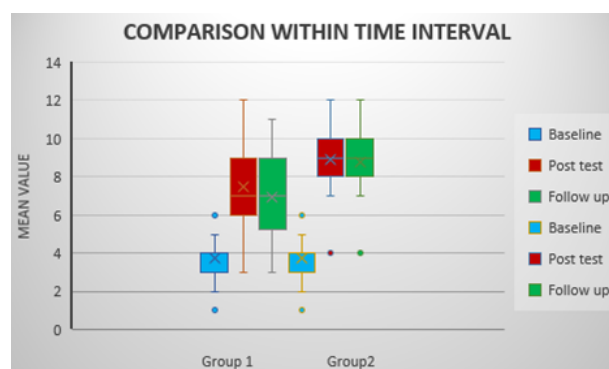
Dental Jumanji is a newly invented game, the first of its kind compared to other games. It has been designed in both English and in the local language (Tamil) for the betterment of education. Other games designed by Maheswari et al,<sup>4</sup> Kumar et al,<sup>11</sup> and Kashyap et al<sup>12</sup> showed similar results.

Maheswari et al<sup>4</sup> conducted a study using similar games where they used flash cards and snakes and ladders game among 5 to 10 year participant. The

**Table 3.** Post hoc comparison within group at different time intervals using Mann-Whitney U test

Group	Time interval	Z value	P value
Group 1- Lecture	Baseline vs post-test	-7.551	0.001**
	Baseline vs 3-month follow up	-6.979	0.001**
	Post-test vs 3-month follow up	-1.142	0.253
Group 2 - Lecture cum Gaming	Baseline vs post-test	-9.042	0.001**
	Baseline vs 3-month follow up	-9.03	0.001**
	Post-test vs 3-month follow up	-0.592	0.554

\*\*P value&lt;0.001, Highly significant.

**Graph 1.** Comparison within both lecture group and lecture cum gaming group at baseline, post-test and 3 months follow up

results showed dramatic increase in knowledge among subjects participating in the group that both played snakes and ladders and used flash cards compared to the one using flash cards only. Maheswari and colleagues' study shows results similar to those of our study, where the combination of lecture and game enhanced the knowledge among participants. Kumar et al<sup>11</sup> conducted a study using a game pattern by connecting the dot game and compared between flash cards among 8- to 10-year-old children. The results showed that the simultaneous use of combined games helps in long term retention of knowledge, which is in line with the results we achieved using our game. A study conducted by Kashyap et al<sup>12</sup> among 12-year school kids as participant used power point presentation and combination of power point presentation and game pattern crossword and puzzle, which showed significant improvement in knowledge compared to pre-intervention and also significant change in knowledge at the 6-month follow-up, which has similar results, where the combination of game and lecture achieved better results than only conventional lectures. The study conducted by Ram Surath Kumar et al<sup>13</sup> showed that interactive visual performance technique improved oral hygiene knowledge and practice than that of conventional oral health educational talk among school going children.

The study by Anwar et al<sup>14</sup> demonstrated that counselling using cartoon animation and audio visual increased knowledge of tooth brushing among children.

A two-year follow-up study conducted by Geetha Priya et al<sup>15</sup> demonstrated that modes of intervention such as drama, modified snake and ladder game, and flashcards showed increase in knowledge.

Educational games can be played as an innovative tool and as an entertainment tool. They are still been used as a teaching and learning method to increase participation by involving reinforcement of knowledge and allowing important points to be reiterated, games appear to have an increased retention of knowledge and application. The core attributes of game play include integrating a friendly environment and structured activities with clear rules in order to improve health and state of being among school children.<sup>16</sup>

Younger kids remember much when involved in cooperative game playing environment. Teachers, parents or siblings supervised game cum education with peers interacting, planning, sharing, and supporting each other improves leaning process.<sup>4</sup> Various studies have shown that games can be used as an effective tool in increasing knowledge, changing behaviour, affecting biological outcomes, and improving self-efficacy.<sup>17</sup>

Young children are receptive at this stage and an ideal time for intellectual growth and personality development.<sup>18</sup> Games have been used as a teaching and learning technique among children and adult to promote participation and self-learning. Children are enthusiastic for participating in games that involve doing tasks. Preventive dentistry is a part of public health dentistry, and its aim is to prevent dental caries in school children, which has been much needed in recent times. As time passes new sugar-based products become available in the market and try to attract school children, resulting in dental caries.

### Limitations

The current experiment with a game was a pilot study, so it was conducted on only one school.

### Recommendation

Further large-scale studies are required to examine both short- term and long-term retention of knowledge and to assess whether the subjects practice the knowledge in their day-to-day activities. "Prevention is the only cure." This proverb tells us the importance of prevention before any bad experience could occur.

### Conclusion

Oral health knowledge increased by using the Dental Jumanji game simultaneously with conventional lectures. Dental Jumanji can be used as a positive reinforcement tool in oral health education.

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### Authors' Contribution

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### Competing Interests

There are no conflicts of interest.

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