ARTIFICIAL INTELLIGENCE LITERACY AMONG PEDIATRIC DENTISTS BASED ON PHRASE RECOGNITION, KNOWLEDGE, AND COMPREHENSION: A PRELIMINARY INVESTIGATION

Jayati Dave[1], Venika Garg[2], Amee Alwani[3]
[1]Private practitioner, Pune, India
[2]Private practitioner, Ahmedabad, Inda
[3]Private practitioner, Ahmedabad, India
Correspondence: venika.garg75@gmail.com

ORIGINAL RESEARCH

ABSTRACT

Background: *Artificial intelligence literacy (AIL) tools have been developed to evaluate whether experts or non-experts can understand and apply AI in their respective professions. However, no model or study exists for assessing AIL in pediatric dentists.* ***Aim:*** *This study aimed to assess the literacy of pediatric dentists in artificial intelligence based on a phrase recognition, knowledge, and comprehension model through a mixed methods approach.* ***Methods:*** *A list of 13 AI-related phrases listed through expert-consensus was sent to participants who rated their interest in AI as three or higher on a 5-point Likert scale. The participants were asked to recognize each phrase. If they answered yes, they were further evaluated for knowledge and comprehension for that phrase qualitatively. If they did not recognize the phrase or incorrectly described it (knowledge), then the literacy assessment for that phrase was not taken to the next step (knowledge or comprehension). Data for 31 participants were tabulated and sent for further analysis.* ***Results:*** *12 out of 31 participants recognized, had knowledge, and comprehended the 13-AI related phrases correctly. Chi-square tests did not reveal a significant association between the three domains. Spearman's correlation coefficient showed high internal consistency between the knowledge and comprehension responses of the participants.* ***Conclusion:*** *AIL of pediatric dentists can be evaluated based on phrase recognition, knowledge, and comprehension model which can be refined by its application on a larger sample.*

Keywords: *Artificial Intelligence, Pediatric Dentistry, Information Literacy, Phrases, Machine Learning*

How to cite: Dave J., Garg V., Alwani A. Artificial intelligence literacy among pediatric dentists based on phrase recognition, knowledge, and comprehension: A preliminary investigation. The Quadrant. 2024;2(3):20-27. https://doi.org/10.5281/zenodo.13709765

INTRODUCTION

Artificial intelligence literacy (AIL) is defined as 'a set of competencies that enables individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI, and use AI as a tool online, at home, and in the workplace'.[1] The speciality domain of AIL has garnered interest in recent times as it is gradually becoming imperative for machine learning technology to take significant control of daily living and workplace. Thus, it becomes a growing need to ensure that non-experts understand the basics of AI conceptually and can have their own perspective and practice of technological advances.

Research involving artificial intelligence in pediatric dentistry has been carried out since the 1990s.[2,3] However, it becomes essential to evaluate if the terminologies related to the field of AI that are mentioned in these research papers are understood by interested readers. The objective of this preliminary investigative paper was two-fold: a) to evaluate the AIL of pediatric dentists, and b) to give a framework to a literacy assessment scale based on recognition, knowledge, and comprehension of AI-related phrases.

METHODOLOGY

To accomplish our objectives, a mixed methods approach was used (Figure 1). The reporting of this study is based on the recommendations of the ASSESS tool.[4] Review articles were searched across relevant databases for articles published in English that focused on AI in pediatric dentistry. Two systematic reviews and two narrative reviews published since 2023 were chosen for full-text screening.[5-8]

Three authors independently listed down all phrases related to AI that they felt pediatric dentists must be aware about. These authors have experience in AI-based applications and machine learning tools for an average of 6.90 years. All three lists were then compared. A total of 24 phrases were listed. If a phrase was mentioned in at least two of the three lists, it was included as a test element. If a phrase was included only in one list, that its inclusion was decided by consensus. Based on this criteria, the final set of phrases that were to be tested for AI literacy in pediatric dentists came to a count of 13. (A list of excluded terms can be available upon a request to the authors).

Dave J., Garg V., Alwani A. Artificial intelligence literacy among pediatric dentists based on phrase recognition, knowledge, and comprehension: A preliminary investigation. The Quadrant. 2024;2(3):20-27.https://doi.org/10.5281/zenodo.13709765

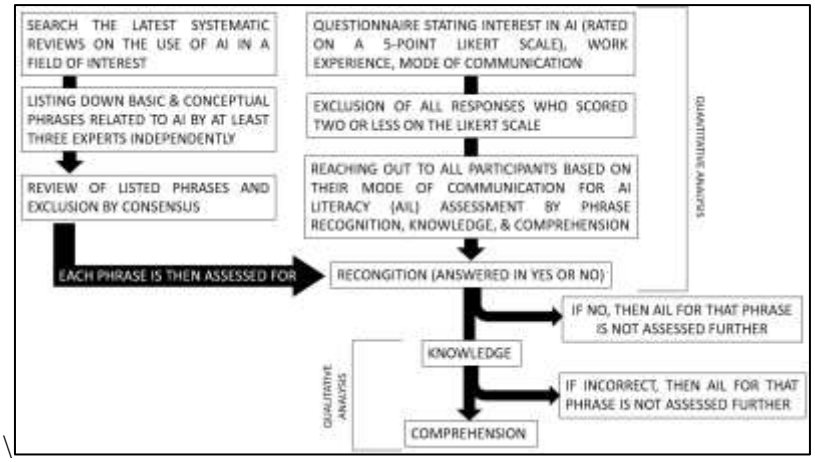

Figure 1 Mixed Methods Approach

A customized digital form was sent to a sample population of pediatric dentists. This included three questions. The first was based on a Likert scale where they were asked to rate their interest in AI in the field of pediatric dentists. In the second question, they were asked to mention their years of experience. The final question was attached with a consent to participate further in the study. Participants were asked to mention their preferred mode of communication. A total of 42 such questionnaires were sent through snowball sampling technique. Participants who scored less than three in the first question were excluded from the study. Participants who scored three or more were contacted based on their preferred mode of communication.

After reaching out the participants in the second phase of our research, the participants were asked about the 13 AI phrases on three fronts: recognition, knowledge, and comprehension. If a participant could recognize the word (answered as yes or no), then they would be asked to describe or define it (knowledge). If this answer was correct, they were then asked to give a relevant dental example about the application of that phrase (comprehension). If the answer in the recognition and knowledge sections were incorrect, then the interview for that phrase would not proceed to the subsequent stages.

After the evaluation of all the participants for the 13 phrases, the data was quantitatively evaluated for recognition and qualitatively for knowledge and comprehension. The answers of knowledge and comprehension were given thematic coding, and common terminologies used by the participants were used to identify the reason behind an answer being correct or incorrect. If a participant could not answer, then it was coded by the statement ‘could not explain.’ The tabulated data was then sent for statistical analysis.

Dave J., Garg V., Alwani A. Artificial intelligence literacy among pediatric dentists based on phrase recognition, knowledge, and comprehension: A preliminary investigation. The Quadrant. 2024;2(3):20-27.https://doi.org/10.5281/zenodo.13709765

RESULTS

Out of the 42 questionnaires sent, 33 scored three or more when asked about their interest in AI in pediatric dentistry. Two of the participants could not be reached or contacted. Thus, the response rate for our questionnaire was 73.80% and statistical analysis was thus done for 31 responses (Table 1). The mean experience of participants in the field of pediatric dentistry was 8.48 years.

Descriptive statistics show that pediatric dentists could recognize an average of 20 phrases (mean: 19.69). However, when asked to describe or define the recognized terms, 13 participants (mean: 13.15) could achieve the task satisfactorily. 12 participants (mean: 12.08) out of the 13 who described the meaning of the phrase could also give a correct example of its application in dentistry or pediatric dentistry (Table 2).

Chi-square statistics were carried out to analyze the relation between recognition, knowledge, and comprehension of the AI phrases. None of the associations showed statistical significance. Spearman correlation coefficient was calculated for each of the three group to compare the direction and strength of the associations. Moderate positive correlation was show between recognition and knowledge, and recognition and comprehension. A strong correlation was shown between knowledge and comprehension indicating that those who had correct knowledge of a phrase were also likely to demonstrate a better comprehension of the same (Table 3).

Since ‘knowledge’ and ‘comprehension’ are two homogenous constructs that contribute to a common underlying factor (assessing AI literacy), it was important to calculate the reliability between the two variables. A Cronbach’s Alpha score of 0.993 indicated a high internal consistency between knowledge and comprehension.

Dave J., Garg V., Alwani A. Artificial intelligence literacy among pediatric dentists based on phrase recognition, knowledge, and comprehension: A preliminary investigation. The Quadrant. 2024;2(3):20-27.https://doi.org/10.5281/zenodo.13709765

PHRASE	Recognize (y/n)	KNOWLEDGE		COMPREHENSION	
		Correct	Incorrect	Correct	Incorrect
AI	Y: 31 N: 0	Robots (n=3) Machine intelligence/assistance (n= 21)	Technological advance (n= 7)	Patient management software (n=1) Behavior Guidance (n=8) Caries diagnosis (13) Radiographic advances (n=2)	-
Narrow AI	Y: 3 N: 28	Weak AI (n=2) Task specific (n=1)	-	Caries diagnosis (n=3)	-
Machine Learning	Y: 31 N: 0	Learning based on input data (n= 4) Algorithm (n= 4) Coding (n=2)	Same as AI (n=21)	Cephalometric analysis (n=2) Caries diagnosis (n=4) Teeth identification (n=4)	-
Deep Learning	Y: 26 N: 5	Advanced form of machine learning (n=3)	Same as AI (n=23)	-	Could not explain (n=3)
Big Data	Y: 2 N: 29	Large dataset (n=2)	-	Multiple radiographic images (n=1) Multiple clinical images of caries (n=1)	-
Algorithm	Y: 31 N: 0	Flowchart (n=11) Planned process in computers (n=5)	Numerical value (n=2) Computer code (n=9) Software language (n=4)	Treatment options (n=16)	-
Virtual Reality	Y: 31 N: 0	VR Box/glasses (n=30) Being in a fictional world (n=1)	-	Behavior Guidance (n=31)	-
Augmented Reality	Y: 27 N: 4	Digital graphics overlap with real world (n=10)	Same as VR (n=17)	Interactive dental games (n=6) Dental education (n=2) Haptic simulation (n=1)	Hologram (n=1)
Remote Monitoring	Y: 11 N: 20	Digitally monitoring patient's treatment outcomes (n=8) Intraoral scans (n=3)	-	Tele-dentistry (n=7) Caries risk assessment (n=1)	Could not explain (n=3)
Neural Network	Y: 6 N: 25	Mapping of data (n=3) Digital mimicry of brain (n=1)	Neuronal connections (n=2)	Patterns learned by AI from multiple images (n=3) Risk factors for caries (n=1)	Could not explain (n=2)
Large Language Model	Y: 23 N: 8	ChatGPT (n=23)	-	Manuscript writing (n=6) Statistical analysis (n=12) Digital content generation (n=1)	For patient education (n=4)
In Silico	Y: 14 N: 17	Studies using computers (n=8) Simulating clinical environment digitally (n=6)	-	Finite element analysis studies (n=5) Using a software for prognosis of treatment (n=2) Diagnostic accuracy of an AI model (n=4)	Could not explain (n=3)
Gamification	Y: 20 N: 11	Child is allowed to play games during dental treatment (n=20)	-	Behavior guidance (n=20)	-

Table 1 Qualitative Analysis

Dave J., Garg V., Alwani A. Artificial intelligence literacy among pediatric dentists based on phrase recognition, knowledge, and comprehension: A preliminary investigation. The Quadrant. 2024;2(3):20-27.https://doi.org/10.5281/zenodo.13709765

PHRASE	RECOGNIZED		KNOWLEDGE		COMPREHENSION	
	Yes	No	Correct	Incorrect	Correct	Incorrect
Artificial Intelligence	31	00	24	07	24	00
Narrow AI	03	28	03	00	03	00
Machine Learning	31	00	10	21	10	00
Deep Learning	26	05	03	23	00	03
Big Data	02	29	02	00	02	00
Algorithm	31	00	16	15	16	00
Virtual Reality	31	00	31	00	31	00
Augmented Reality	27	04	10	17	09	01
Remote Monitoring	11	20	11	00	08	03
Neural Network	06	25	04	02	04	02
Large Language Model	23	08	23	00	19	04
In Silico	14	17	14	00	11	03
Gamification	20	11	20	00	20	00

Table 2 Qualitative Analysis

Variables	Chi-square Statistic	p-value	Spearman Correlation	p-value
Recognition vs Knowledge	95.87	0.316	0.613	0.026
Recognition vs Comprehension	117	0.261	0.627	0.022
Knowledge vs Comprehension	130	0.251	0.967	<0.001

Table 3 Tests of significance and association

DISCUSSION

A total of 16 assessment tools for AIL have been recently analyzed in a systematic review. However, none of them have been specifically developed for the field of dentistry. Though the Scale for Assessment of Non-Experts' AI Literacy (SNAIL) exists, its content validity remains questionable with low reliability.[9]

Word recognition and comprehension has been previously used for assessing literacy in healthcare.[10] Assessment of literacy in a subject have been evaluated based on conventional models and frameworks like Bloom's taxonomy, The Five Big Ideas, Digital Literacy Frameworks, Socio-technical Perspective, Ecological Systems Theory, Computational Thinking, TPACK Framework, etc.[11] The common constructs in these frameworks are "use and apply" (82%), "know and understand" (73%), recognize and create (64%).[12] The model used in our preliminary investigation included three of these factors: recognition, knowledge, and comprehension. Though this model can

Dave J., Garg V., Alwani A. Artificial intelligence literacy among pediatric dentists based on phrase recognition, knowledge, and comprehension: A preliminary investigation. The Quadrant. 2024;2(3):20-27.https://doi.org/10.5281/zenodo.13709765

be applied to assess AI-relation phrase proficiency in any field, we used pediatric dentists as our sample as it was the field of expertise of the evaluators in this study.

The results of our study showed that only 12 of the 31 participants recognized, had knowledge, and could comprehend the 13 AI-related phrases correctly. The cross-sectional design of our study can help in understanding the current status of AIL in a given field. Though the scale comprehensively illustrates both qualitative and quantitative assessment, it lacks cross-cultural validity, measurement invariance, and measurement error which is a limitation worthy of mention. These can be overcome by assessment of AIL on a larger sample size.

REFERENCES

1. Long D, Magerko B. What is AI Literacy? Competencies and Design Considerations. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems. 2020 Apr 21
2. Nilsson T, Lundgren T, Odelius H, Sillén R, Norén JG. A computerized induction analysis of possible co-variations among different elements in human tooth enamel. Artif Intell Med. 1996 Nov;8(6):515-26. doi: 10.1016/s0933-3657(96)00350-8.
3. Klingberg G, Sillén R, Norén JG. Machine learning methods applied on dental fear and behavior management problems in children. Acta Odontol Scand. 1999 Aug;57(4):207-15. doi: 10.1080/000163599428797.
4. Ryan N, Vieira D, Gyamfi J, Ojo T, Shelley D, Ogedegbe O, et al. Development of the ASSESS tool: a comprehenSive tool to Support rEporting and critical appraiSal of qualitative, quantitative, and mixed methods implementation reSearch outcomes. Implementation Science Communications. 2022 Mar 28;3(1).
5. Salvatore La Rosa, Quinzi V, Palazzo G, Ronsivalle V, Antonino Lo Giudice. The Implications of Artificial Intelligence in Pedodontics: A Scoping Review of Evidence-Based Literature. Healthcare. 2024 Jun 30;12(13):1311–1.
6. Mahajan K, Kunte SS, Patil KV, Shah PP, Shah RV, Jajoo SS. Artificial Intelligence in Pediatric Dentistry – A Systematic Review. Journal of Dental Research and Review [Internet]. 2023 Jan 1 [cited 2023 Oct 17];10(1):7.
7. Alessa N. Application of Artificial Intelligence in Pediatric Dentistry: A Literature Review. Journal of pharmacy and bioallied sciences. 2024 May 1;16(Suppl3).
8. Acharya S, Godhi BS, Saxena V, Assiry AA, Alessa NA, Dawasaz AA, Alqarni A, Karobari MI. Role of artificial intelligence in behavior management of pediatric dental patients-a mini review. J Clin Pediatr Dent. 2024 May;48(3):24-30. doi: 10.22514/jocpd.2024.055.
9. Lintner T. A systematic review of AI literacy scales. NPJ Sci Learn. 2024 Aug 6;9(1):50. doi: 10.1038/s41539-024-00264-4.
10. Almatrafi O, Johri A, Lee H. A Systematic Review of AI Literacy Conceptualization, Constructs, and Implementation and Assessment Efforts (2019-2023). Computers and Education Open. 2024 Mar 1;6:100173–3

Dave J., Garg V., Alwani A. Artificial intelligence literacy among pediatric dentists based on phrase recognition, knowledge, and comprehension: A preliminary investigation. The Quadrant. 2024;2(3):20-27.https://doi.org/10.5281/zenodo.13709765

11. Ng DTK, Leung JKL, Chu SKW, Shen MQ. Conceptualizing AI literacy: An exploratory review. Computers and Education: Artificial Intelligence. 2021 Nov 22;2(1):100041.
12. Almatrafi O, Johri A, Lee H. A Systematic Review of AI Literacy Conceptualization, Constructs, and Implementation and Assessment Efforts (2019-2023). Computers and Education Open. 2024 Mar 1;6:100173

Dave J., Garg V., Alwani A. Artificial intelligence literacy among pediatric dentists based on phrase recognition, knowledge, and comprehension: A preliminary investigation. The Quadrant. 2024;2(3):20-27.https://doi.org/10.5281/zenodo.13709765