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Metaverse in Dentistry: Connecting Virtual Innovation with Real World Patient Care and Education

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Abstract: Integration of metaverse technology in dentistry is transforming patient treatment, education and professional growth. This investigation examines the awareness, attitude and preparation of dental students and practitioners regarding metaverse applications in their field of work. Hence, 201 participants were asked about their awareness of artificial intelligence, XR, block-chain and digital twins, together with the various advantages and disadvantages of these technologies. While metaverse adoption is widely sought, especially in education and training, questions about cost, privacy and usability still linger. Thus, the need for structured learning programs to maximize the benefits of metaverse technology and raise dental practitioners' digital proficiency is highlighted.

Aim: To investigate opinions of dental students regarding AR, AI, digital twins in their fields.

Objective: To assess dental student's knowledge attitude and practice regarding integration of metaverse technologies like augmented reality (AR), AI, and digital twins in their fields

Method: A cross-sectional survey was conducted among 201 dental students, comprising 64 males (31.8%) and 137females (68.2%). The survey included 14 questions about Metaverse in dentistry: Connecting virtual innovation with real-world patient care and education among undergraduate dental students were analyzed based on gender, age and year of study using chi-square tests to identify statistically significant differences.

Keywords: Artificial Intelligence, dental education, extended reality, metaverse, patient care.

INTRODUCTION:

Among the disciplines most likely to be disrupted digitally, dentistry has revolutionized healthcare most radically with technology. Dental patient treatment, education and professional training can be changed by extended reality (XR), artificial intelligence (AI), block-chain, cloud computing and metaverse, an immersive digital environment. Virtual simulations, AI-driven diagnostics and tele-dentistry applications

represent among the main innovations that can increase access, accuracy and participation in dental practice. The potential to create interactive and immersive learning environments, offer remote consultations and allow precision- driven dental surgeries utilizing digital twins and AI-based analytics shows the immense opportunities of this technology.

Though metaverse technologies in dentistry offer significant benefits, knowledge of and acceptance of them remain rare. Many students and dental professionals do not know enough about the applications, challenges and moral concerns around adding the metaverse into ordinary surgeries. Knowing the degree of knowledge and preparedness among dental students and professionals would help one estimate the future relevance of this technology in dentistry. Therefore, it is of interest to assess the knowledge, opinion and preparedness of 201dental students to incorporate metaverse technology into their clinical and academic operations.

METHODOLOGY:

A. study design and area: A cross-sectional study was carried out at tertiary care teaching hospital khammam.
B. survey
   Study population: The health care students including those of first year to internship dental students who responded to the offline paper print questionnaire
C. Study Instrument: A self-administered questionnaire was designed based on Metaverse in dentistry: Connecting virtual innovation with real-world patient care and education had a total 14 questions. Each participant has to fill their demographic data like Name, age, and year of study. Participants have to select one option from the answers provided against questions and the questions were based Metaverse in dentistry: Connecting virtual innovation with real world patient care and education
D. Pilot study: A pilot study was conducted on a group of students to assess the validity and reliability of study
E. Sampling method: The sampling method used is convenience method
F. Inclusion criteria: The students who were interested in study and who are willing to participate
G. Exclusion criteria: students who are not willing to participate are excluded
H. Organizing the study: The study was designed in a paper-based version of the self administered questionnaire of 14 questions focusing on knowledge, awareness. Includes the sections of demographic data: Name, Age, Sex and Year of study demographic information and asked to answer all questions by selecting one option from the provided answers.
   Statistical analysis: Data from the filled questionnaire was conducted in a tabular form in an excel worksheet and evaluated for analysis the analysis was performed by SSPS version 29.

RESULTS:

A total of 201 students took part in this with females (68.2%) and male of (31.8%). Age of the participants ranging from 21-25 years. In this study Females were more likely to demonstrate perception in dissection room experiences than male. Significantly second and third years showed greater familiarity with advanced applications than first, fourth years and intern students.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	201	19	34	22.58	1.306

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	64	31.8	31.8	31.8
	Female	137	68.2	68.2	100.0
	Total	201	100.0	100.0	

Year of study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I BDS	9	4.5	4.5	4.5
	II BDS	33	16.4	16.4	20.9
	ÌII BDS	33	16.4	16.4	37.3
	IV BDS	52	25.9	25.9	63.2
	INTERN S	74	36.8	36.8	100.0
	Total	201	100.0	100.0	

Distribution and comparison of responses based on gender:

Item	Response	Males		Females		Chi-Square value	P value
		n	%	n	%		
Q1	1	43	25.4	126	74.5	3.173	0.366
	2	9	60.0	6	40.0		
	3	12	70.5	5	29.5		
Q2	1	4	21.1	15	78.9	12.485	0.006*
	2	5	41.7	7	58.3		
	3	28	23.6	82	76.4		
	4	26	48.3	31	51.7		
	5	1	33.3	2	66.6		
Q3	1	8	38.1	13	61.9	5.219	0.156
	2	10	31.2	22	68.8		
	3	19	44.2	24	55.8		
Q4	1	18	24.7	55	75.3	4.230	0.238
	2	18	42.9	24	57.1		
	3	18	34	35	66		
Q5	1	8	20.5	31	79.5	14.237	**0.003***
	2	10	35.7	18	64.3		
	3	17	60.7	11	39.3		
Q6	1	11	26.2	31	73.8	3.231	0.357
	2	14	36.8	24	63.2		
	3	10	45.5	12	54.5		
	4	29	29.3	70	70.7		
Q7	1	8	20.5	31	79.5	7.713	**0.05***
	2	14	51.9	13	48.1		
	3	10	27	27	73		
	4	32	32.7	66	67.3		
Q8	1	16	25	48	75	3.201	0.362
	2	11	44	14	56		
	3	16	32	34	68		
Q9	1	11	30.6	25	69.4	2.874	0.411
	2	12	30.8	27	69.2		
	3	12	46.2	14	53.8		
Q10	1	17	28.3	43	71.7	1.515	0.679
	2	11	31.4	24	68.6		
	3	16	29.6	38	70.4		
Q11	1	56	53.8	18	46.2	12.665	**0.005***
	2	8	33.3	16	66.7		
Q12	1	22	53.7	19	46.3	18.048	**0.001***

	2	14	41.2	20	58.8		
	3	19	19	81	81		
	4	9	34.6	17	65.4		
Q13	1	24	52.2	22	47.8	13.654	**0.003***
	2	7	33.3	14	66.7		
	3	23	21.9	82	78.1		
	4	10	34.5	19	65.5		
Q14	1	27		116		13.722	**0.03***
	2	10	34.5	19	65.5		
	3	23	22.1	81	77.9		
	4	4	26.7	11	73.3		

P≤0.05 is statistically significant

Distribution and comparison of responses based on year of the study:

Item	Response	I BDS		II BDS		III BDS		IV BDS		INTERN		Chi- Value	P-Value
		n	%	n	%	n	%	n	%	n	%		
Q1	1	4	2.3	28	16.5	24	14.2	48	28.4	65	38.4	26.673	0.009*
	2	3	20.	2	13.3	4	26.6	2	13.3	4	26.6		
	3	2	11.	3	17.6	5	29.4	2	11.7	5	29.4		
Q2	1	3	15.	5	26.3	1	5.3	1	5.3	9	47.4	24.096	**0.02***
	2	0	0	3	25	1	8.3	4	33.3	4	33.3		
	3	3	2.7	17	15.5	14	12.7	30	27.3	44	41.8		
	4	3	5	8	13.3	16	28.3	17	28.3	15	25		
	5	0	0	0	0	1	33.3	0	0	2	66.6		
Q3	1	2	9.5	7	33.3	3	14.3	4	19	5	23.8	9.727	0.640
	2	1	3.1	7	21.9	4	12.5	9	28.1	11	34.4		
	3	2	4.7	7	16.3	7	16.3	10	23.3	17	39.5		
Q4	1	4	5.5	11	15.1	10	13.7	18	24.7	30	41.1	5.351	0.945
	2	2	4.8	10	23.8	7	16.7	10	23.8	13	31		
	3	2	3.8	7	13.2	8	15.1	15	28.3	21	39.6		
Q5	1	3	7.7	4	10.3	7	17.9	8	20.5	17	43.6	14.106	0.294
	2	0	0	7	25	6	21.4	10	35.7	5	17.9		
	3	1	3.6	5	17.9	7	25	8	28.6	7	25		
Q6	1	1	2.4	7	16.7	9	21.4	12	28.6	13	31	7.743	0.805
	2	2	5.3	8	21.1	7	18.4	8	21.1	13	34.2		
	3	0	0	5	22.7	4	18.2	7	31.8	6	27.3		
	4	6	6.1	13	13.1	13	13.1	25	25.3	42	42.4		
Q7	1	1	2.6	7	17.9	7	17.9	12	30.8	12	30.8	9.985	0.617
	2	2	7.4	3	11.1	3	11.1	7	25.9	12	44.4		
	3	4	10.	8	21.6	4	10.8	9	24.3	12	32.4		
	4	2	2	15	15.3	19	19.4	24	24.5	38	38.8		
Q8	1	4	6.2	8	12.5	11	17.2	15	23.4	26	40.6	15.342	0.223
	2	0	0	6	24	2	8	4	16	13	52		
	3	4	8	9	18	6	12	12	24	19	38		
Q9	1	1	2.8	7	19.4	7	19.4	12	33.3	9	25	7.847	0.797
	2	2	5.1	6	15.4	7	17.9	6	15.4	18	46.2		
	3	2	7.7	3	11.5	4	15.4	9	34.6	8	30.8		
Q10	1	2	3.3	11	18.3	11	18.3	14	23.3	22	36.7	7.788	0.801
	2	1	2.9	8	22.9	4	11.4	9	25.7	13	37.1		

	3	3	5.6	10	18.5	8	14.8	17	31.5	16	29.6		
Q11	1	8	4.5	27	15.2	29	16.3	47	26.5	66	37.2	2.828	0.997
	2	1	4.2	6	25	4	16.7	5	20.8	8	33.3		
Q12	1	2	4.9	9	22	10	24.4	9	22	11	26.8	15.577	0.211
	2	1	2.9	4	11.8	3	8.8	12	35.3	14	41.2		
	3	5	5	17	17	11	11	26	26	41	41		
	4	1	3.8	3	11.5	9	34.6	5	19.2	8	30.8		
Q13	1	2	4.3	7	15.2	9	19.6	12	26.1	16	34.8	9.977	0.618
	2	1	4.8	3	14.3	6	28.6	7	33.3	4	19		
	3	5	4.8	16	15.2	12	11.4	29	27.6	43	41		
	4	1	3.4	7	24.1	6	20.7	4	13.8	11	37.9		
Q14	1	3	5.7	9	17	8	15.1	13	24.5	20	37.7	13.938	0.305
	2	2	6.9	5	17.2	6	20.7	11	37.9	5	17.2		
	3	3	2.9	19	18.3	14	13.5	26	25	42	40.4		
	4	1	6.7	0	0	5	33.3	2	13.3	7	46.7		

P≤0.05 is statistically significant

DISCUSSION :

Kalaimani et al. highlighted important gaps in reason, particularly technologies despite the general consciousness of nascent digital tools. While Kalaimani's study shows 63.5% awareness of AI among participants, our study reflects a higher awareness of 76.9% specifically regarding AI Uses in diagnostics and treatment was planning. Notwithstanding both studies, it is necessary to take further targeted informative initiatives to work these gaps and better the reason for particular uses in dentistry regarding attitudes both studies break bold perspectives along integration of artificial intelligence into dental do. Most participants in both studies showed their forecast about AI's potential to improve dental care and educational opportunities. Similarly, both studies spotlight the development concern in incorporating artificial intelligence into the program to check that dental professionals are spread to employ these technologies when it comes to doing our information. However, both studies also suggest that practical use and hands-on encounters remain areas that need further development. Dzyuba et al. study regarding practice, both studies share the perspective that hands-on learning and immersive training tools, such as VR simulations or Metaverse applications, can significantly enhance clinical education and patient interactions. There is a shared belief that these technologies offer a way to bridge gaps in traditional training, especially in complex procedures where risk-free practice is essential. Zhu et al. study and our data show a strong positive attitude toward the integration of digital technologies in dentistry, including AI, Metaverse and XR tools. Both studies find that there is high enthusiasm for incorporating new technologies into clinical practice and education. This is reflected in the high percentage of participants in both studies expressing willingness to adopt these tools, especially for improving patient care, education and training. Our study highlighted the potential of Metaverse technologies, particularly VR and XR, in dental education, enhancing training through immersive learning environments and hands-on experiences. Chauhan et al. also emphasized the role of tele-dentistry and AI-driven diagnostics in improving patient care, with virtual consultations helping to reduce dental anxiety and personalize patient experiences. However, both studies identify significant knowledge gaps about technologies like blockchain, AI and XR, stressing the need for structured training. Cost and privacy concerns are major barriers to adoption in both clinical and educational settings. Lastly, both studies call for further research, policy development and financial support to integrate these technologies into dental curricula and expand professional training.

CONCLUSION:

With enormous enthusiasm among students especially in education, training and patient care, the metaverse seems to have significant promise to transform dentistry. Successful adoption depends on addressing issues including cost, privacy and knowledge gaps. The dentistry sector may use the metaverse to improve patient outcomes and professional

training with correct education, policy creation and financial assistance.

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