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ORIGINAL RESEARCH ARTICLE

A Comperative Study of Use of Artificial Intelligence in Oral Radiology Education

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Abstract

Purpose: The aim of this study is to compare the efficacy of artificial intelligence use in oral radiology learning in the undergraduate dental students.
Materials and Methods: Fifty third-year students in the University of Lokman Hekim were detected images with the artificial intelligence method (AI) and standard lecture method (SL) for anatomical landmarks in panoramic radiographs. SL consisted of a frontal lecture through a standardized presentation. CranioCatch model (Eskisehir, Turkey) was used as deep learning-based artificial intelligence model. One panoramic image was loaded to the application and anatomic landmarks were detected by instructor, students were asked to mark. AI recorded and scored students answers. A questionnaire study was conducted for the perception of students in terms of validity and reliability regarding assessment and evaluation for each methods.
Results: 50 undergraduate students (26 female, 24 male) answered 7 questions, 5-point Likert type. The conformity to the normal distribution was evaluated with the Shapiro-Wilk test and the graphical approach (Normal Q-Q Plot). The values did not conform to the normal distribution. As a result of the reliability analysis performed for the measurement tool, the Cronbach's Alpha coefficient was found 0.828. Wilcoxon Test was used to test the significance of the difference between each methods. There is a statistically significant difference between the mean values of evaluation measurements(p=0.014). AI was higher than the mean of evaluation measurement values compared to SL.
Conclusions: AI models have performed very well in measurement and evaluation in oral radiology learning.

Key words: anatomic landmarks; artificial intelligence; dental education; dental restoration; panoramic image

Introduction

Dental education differs from any other form of medical education as it is a combination of theory, laboratory, and clinical practice.[1] Dental education involves both didactic and clinical skills training.[2] In radiology it is primer to know image interpretation.

A considerable part of traditional classrooms involves teaching through lectures, with passive transfer of knowledge to students via teacher-centred learning methods.[3] Though delivery of a single lecture to a large group of students is cost-effective, this pedagogical method is often ineffective because students'attention is difficult to maintain for durations longer than fifteen minutes.[4] Dental skills are built with emphasis on experiences. Active learning strategies, promoting the ability to think critically, engaging in self-directed learning and adapting to the diverse learning styles of the students, are associated with the development of the mental capacities needed for the expert practice of dentistry.[5] Since artificial intelligence (AI) was first introduced in 1956 at Dartmouth University[6], AI has been exponentially expanding in all fields. AI connotes fundamental technologies including machine learning, artificial neural networks (ANN), and deep learning.[7]

There are some softwares that develop artificial intelligence solutions for clinical AI applications and training modules in dentistry. Recently, AI began to be used in many fields of dentistry such as orthodontics, oral and maxillofacial surgery, therapeutic dentistry, periodontology, endodontics, craniofacial disorders including cleft management, prosthodontics and smile design, airway management, forensic dentistry, imaging technology.[8–28]

In addition to these areas of use, artificial intelligence has also gained a place in the field of dentistry education. Augmented reality and virtual reality are being used widely in the field of dental education to create situations that simulate clinical work on patients and eliminate all the risks associated while training on a live patient.[29] The AI allows the students to evaluate their work and compare it to

Figure 1. Image from the lesson with the SL method

the ideal thus creating high-quality training environments.[30,31] In this study, artificial intelligence was used in oral radiology learning and students were evaluated with this software and also the efficacy of AI was compared with standart lecture method (SL) in the undergraduate dental students.

Material and Methods

Participants

The study involved all third-year undergraduate dental students (26 female, 24 male) at the Faculty of Dentistry of Lokman Hekim University. Students were informed that they could withdraw from the study at any time. The study protocol was approved by the Non-Interventional Clinical Research Ethics Committee of the University of Lokman Hekim University Committee of Research and Publication Ethics (2022/92).

Teaching and Evaluation Tools and Methods in this Study

Two teaching tools were adopted: (1) "Standard Lecture (SL)" consisting of a frontal lecture through a standardized presentation of 5 slides (Microsoft Office PowerPoint version 12.0, Microsoft, Redmond, WA, US), which included panoramic image of an adult patient (Figure 1) The students were asked to write down the anatomical landmarks in the panoramic image they saw on the slide. All the papers were evaluated and scored by two lecturers. (Figure 2) (2) "Deep Learning-Based Artificial Intelligence Model (AI)" where radiographic images were uploaded to the application and students logged in by personal identification number and marked the anatomic landmarks. (Figure 3)

An artificial intelligence (AI) algorithm (CranioCatch, Eskisehir-Turkey) was used as deep learning-based AI model. One panoramic image was loaded to the application and anatomic landmarks were detected by lecturer, students were asked to mark. AI recorded and scored students answers. (Figure 4)

A questionnaire study was conducted for the perception of students in terms of validity and reliability regarding assessment and evaluation for each methods using Google Forms including 7 questions, 5-point Likert type. The students were asked to answer the following questions in the form regarding the use of both methods in education, with 1 being the least and 5 the most.

- Question 1: I think the exam measures everything I need to know.
- Question 2: I think the exam measures what I need to know correctly.
- Question 3: I think that this exam will have a positive effect on my decision making in the diagnosis and treatment process in bedside applications in the clinic.
- Question 4: I think this exam can distinguish between those who know and those who don't.
- Question 5: I think the evaluation of the exam is objective, eliminating the possibility of lecturer error.
- Question 6: I think this exam measures what it is supposed to measure.
- Question 7: I think this exam is easy/difficult with 1 being the easiest and 5 the most difficult.

At the same time, students were asked to share their opinions

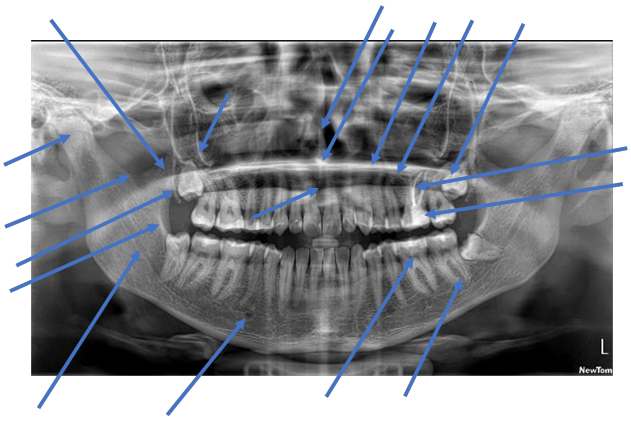

Figure 2. Anatomic landmarks arrowed in panoramic image

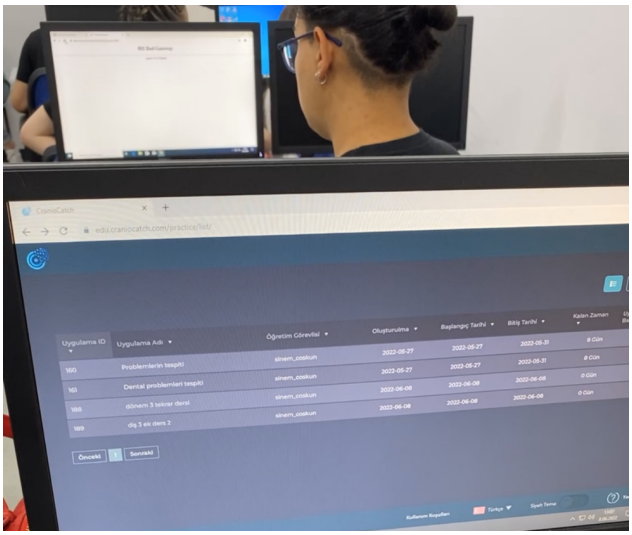

Figure 3. Image from the lesson with the AI method

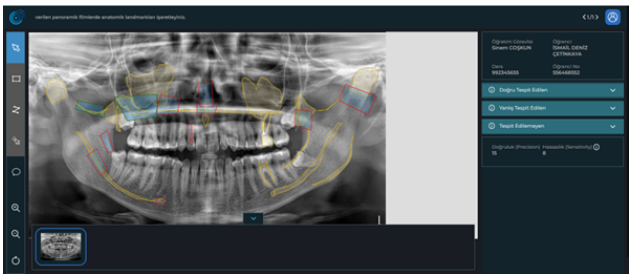

Figure 4. Scores of students answers Precision and sensitivity values

Figure 5. The presentation of AI application to students

and suggestions about both methods. Each student received a complete set. Two lecturers who were both maxillofacial radiologist participated in the study. Prior to the evaluation of knowledge about anatomic landmarks, one lecturer presented the methods to the students how to use the application, what is expecting from them, time spent on each procedure. (Figure 5)

Statistical Analysis

Statistical analysis was performed using the IBM SPSS 27.0 package program. Normal distribution suitability was evaluated by Shapiro-Wilk test and graphical approach (Normal Q-Q Plot). The measurement values did not conform to the normal distribution ($p<0.05$). As a result of the reliability analysis for the measurement tool (7 questions, 5-point Likert type), Cronbach's Alpha coefficient was found to be 0.828. The scale is highly reliable. Wilcoxon Test was used for significance test to evaluate the difference between SL and AI.

Results

50 volunteer undergraduate students (26 female, 24 male) participated in the study. In SL, students were asked to write the name of the anatomical landmark indicated by an arrow on the panoramic radiograph. From anatomical landmarks, coronoid process, zygoma, foramen incisivum, nasal septum, spina nasalis anterior, hard palate, maxillary sinuses, impacted teeth, restorative materials such as gutta percha and composite resin, lamina dura, pulp, foramen mentale, canalis mandibularis, linea obliqua externa, tuber maxilla, incisura mandibula, mandibular condyle were asked in both method.

A minimum of 2 and a maximum of 15 points out of 18 with mean range 9±3.29 were obtained in the standard lecture method. First, a panoramic radiograph was loaded into the application and anatomical landmarks were defined in the panoramic radiograph by lecturers. All students with a 50% acceptable margin of error marked the anatomical landmarks in the panoramic films. The application showed and evaluated results for each student. (Figure 6)

Statistical analysis was performed using the IBM SPSS 27.0 package program. The conformity to the normal distribution was evaluated with the Shapiro-Wilk test and the graphical approach (Normal Q-Q Plot). It was decided that the measurement values obtained did not conform to the normal distribution ($p<0.05$). As a result of the reliability analysis performed for the measurement tool (7 questions, 5-point Likert type), the Cronbach's Alpha coefficient

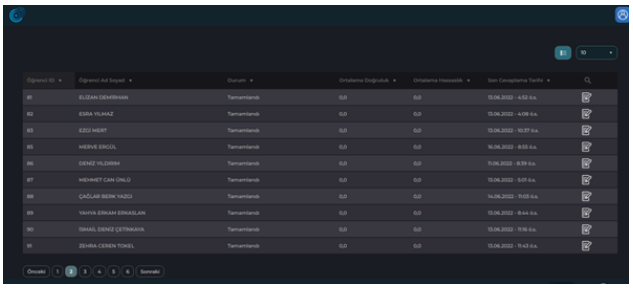

Figure 6. Detection the student results by application

Table 1. Descriptive Analyses

	Standard Lecture Method			Artificial Intenlligence	
Question	Min	Max	Med	Min	Max
1	1	5	4	1	5
2	1	5	4	2	5
3	1	5	5	1	5
4	1	5	4	1	5
5	1	5	4	1	5
6	1	5	4	1	5
7	1	5	3	1	5

was found to be 0.828. Wilcoxon test was used to test the significance of the difference between SL method and AI method. For both methods, the median, minimum and maximum values are given as descriptive statistics. (Table 1) Frequency analysis was performed for each question. (Table 2) There is a statistically significant difference between the averages of evaluation measurement values regarding the use of AI method and SL method. (Test statistic $Z=-2.452$; $p=0.014<0.05$). (Table 3) According to this finding, it was seen that the average of the evaluation measurement values for the use of SL method was lower than AI method.

Student's Comments Reported in the Subjective Assessment

In addition, students were asked to express their opinions about both methods. Students experiencing AI method reported positive comments, such as 'The artificial intelligence method is more effective than the classical method in terms of learning and memorability.' and 'I think AI will be effective for undergraduate education in diagnosing the patient.', 'I think that the educational aspect of the AI is higher and it is a future-oriented method.' 'Craniocatch application is an advantageous method for holistic detailed examination, inquiry and learning.' And also some students reported that they want both methods to be used together. And some reported that they some difficulties using application by tablets and mobile phones and suggested that it could be improved.

Discussion

The clinical use of AI programs in dentistry has gained popularity over the last few years. Applications of AI in dentistry are quite exiting, especially in radiology. AI applications are developed in fields of dentistry to help in the tracing of cephalometric landmarks; in the detection of caries, alveolar bone loss, and periapical pathosis; the auto-segmentation of the inferior alveolar nerve; the analysis of facial growth.[32–36]

In addition to these, AI programs have been developed in dentistry education.[30,33,37] Today, traditional theoretical lectures are being replaced by lectures with awe-inspiring images, dynamic videos, and interactive exercises. Since 2013 the growth of research into AI and use of AI has been developing rapidly.

Table 2. Frequency Analysis

	Score	SL Method	AI Method	Total
Q 1: I think the exam measures everything I need to know.	1	1	1	2
	2	2	2	4
	3	14	13	27
	4	24	24	48
	5	9	10	19
Total		50	50	100
Q 2: I think the exam measures what I need to know correctly.	1	1	0	1
	2	2	3	5
	3	15	9	24
	4	19	30	49
	5	13	8	21
Total		50	50	100
Q 3: I think that this exam will have a positive effect on my decision making in the diagnosis and treatment process in bedside applications in the clinic.	1	1	1	2
	2	5	0	5
	3	13	4	17
	4	16	17	33
	5	15	28	43
Total		50	50	100
Q 4: I think this exam can distinguish between those who know and those who don't.	1	4	1	5
	2	5	4	9
	3	10	5	15
	4	19	29	48
	5	12	11	23
Total		50	50	100
Q 5: I think the evaluation of the exam is objective, eliminating the possibility of lecturer error.	1	1	1	2
	2	7	1	8
	3	18	10	28
	4	16	17	33
	5	8	21	29
Total		50	50	100
Q 6: I think this exam measures what it is supposed to measure.	1	1	1	2
	2	2	2	4
	3	15	8	23
	4	20	23	43
	5	12	16	28
Total		50	50	100
Q 7: I think this exam is easy/difficult with 1 being the easiest and 5 the most difficult.	1	2	3	5
	2	3	6	9
	3	20	17	37
	4	14	16	30
	5	11	8	19
Total		50	50	100

Table 3. Test Statistics[a]

	AI method measurement values average - SL method measurement values average
Z	2,452[b]
Asymp. Sig. (2-tailed)	0.014

a. Wilcoxon Signed Ranks Test b. Based on negative ranks.

In this study, a newly developed artificial intelligence application was used in maxillofacial radiology training. anatomical landmark subject was taught and the exam was evaluated using AI method. Students reported that both methods yielded similar results in measuring all they needed to know. When both methods were compared, students reported that they thought AI was more effective in measuring accurately. And also students reported that, AI has a significantly more positive effect than SL on decision making in the diagnosis and treatment process in bedside applications in the clinic. AI models not only help undergraduate students in their preclinical decision-making processes, but also allow the trainer to evaluate with minimal errors.

Results of this study showed that AI was more effective than SL in the assessment of being able to distinguish between those who know and those who do not know. And also AI was found to be more reliable in objective evaluation and elimination of lecturer errors. Both methods showed similar results in measuring what it was supposed to measure. When difficulty levels are compared, both methods had similar difficulty levels. The small number of students included in the study is one of the limitations of the study. One of the most important deficiency of this new application is that it is not yet applicable to all devices such as mobile phone and tablet. However, it should be sured to do that these features may also be available with appropriate software in the near future.

Conclusion

The use of artificial intelligence in dentistry education, especially in maxillofacial radiology, should be used as a very effective method both for undergraduate education of students and for the assessment and evaluation process. It should be improved new educational methods to standardize the methodology for the oral radiology education especially for AI application. Future studies should quantitatively investigate different assessment methods and students of different age groups to find out the best tools for the teaching of oral radiology. It is foreseen that it will contribute to the clinical decision-making processes of the students by allowing the elimination of instructional errors.

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Author Contributions

Conceived and designed the analysis: S.C.,M.G. , Collected the data: S.C.,M.G., Contributed data: S.C.,M.G., Performed the analysis: S.C.,M.G., Wrote the paper: S.C.,M.G.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

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