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Original Article

Development of an Educational Software for Diagnosis in Oral Medicine and Evaluation of Dental Students' Attitudes: An Educational Intervention

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ABSTRACT

Background: An oral examination might reveal important diagnostic information regarding a patient's general health. There are several natural changes in the soft tissue structures of the mouth that may resemble a pathological condition. The aim of this research was to develop an educational web- based application for diagnosis in oral medicine and evaluation of the students' attitudes towards it.

Methods: This educational intervention involved one sample group and was conducted from September to December 2019. In the first step, the educational software was designed based on the ADDIE instructional design model. In the second step, 30 dental students were selected by census sampling, and their attitudes towards the designed educational web application were assessed. The web-based educational application was developed using the asp.net web form framework and the #c programming language. The standard kaplan educational product questionnaire was used to assess dental students' attitudes. Descriptive statistics including the mean, standard deviation, percentage, and frequency were used. Statistical significance was calculated for the components of the questionnaire using the one sample t-test and the cut-off point of 3. SPSS V26 was used to analyze the tests.

Results: The majority of students had positive attitudes in all 12 domains of the questionnaire including objectives (P=0.0001), assessment (P=0.0001), practice (P=0.0001), examples (P=0.0001), information (P=0.001), multimedia (P=0.028), overviews (P=0.011), integration (P=0.144), motivation (P=0.0001); organization (P=0.003), usability (P=0.0001), and personalization (P=0.144) which were significantly greater than average and were acceptable. Despite the difference between the two domains (integration and personalization) with the average score, no statistically significant difference was seen.

Conclusion: The innovative educational software was successfully developed. The results revealed that students were extremely satisfied with the quality of the educational software. As a result, it can be effectively employed as a teaching aid when combined with conventional education.

Keywords: Dentistry, Education, Software design, Attitudes, Online learning, Virtual learning

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Introduction

An oral examination might reveal important diagnostic information regarding a patient's general health. There are several natural changes in the soft tissue structures of the mouth that may resemble a pathological condition. Understanding these changes helps the dentists distinguish between normal and abnormal changes and, if necessary, determine the appropriate management (1). Early diagnosis of maxillofacial disorders enables the dentist to provide the patient with proper dental care while also preventing problems from progressing to more advanced stages. As a result, detecting normal variations is critical (2, 3).

Today's medical science educators face different challenges than in the past when it comes to training medical students, including new physicians, pharmacists, and dentists. Due to the increasingly strong development of information and communication technologies, traditional teaching methods are not enough to meet the educational needs of the new generation students (4, 5). The outbreak of the COVID-19 pandemic as a global health crisis has also affected education, with many countries closing schools and universities to prevent the spread of the disease. As a result, schools and universities faced an unprecedented challenge and were forced to use e-learning tools to deal with this global crisis. Therefore, the use of new educational methods, such as education through electronic content, has become essential (6, 7).

E-learning is a kind of learning system that is provided to students via computers and Internet technologies. E-learning is based on the use of communication technologies, and, accordingly, communication infrastructure and systems are needed to launch it (8). The efficiency and effectiveness of e-learning depend on flexible educational design, e-content, and adherence to the appropriate standards in their design (9). Several studies have shown that e-learning can improve medical students' learning, motivation, and satisfaction (10, 11). Improved access to suitable technologies for e-learning has opened a new horizon for educational foundation. Providing a perfect learning context is considered as a criterion of educational quality including active learning and continuous learning (12-14). In their study, Woelber et al. investigated the use of several integrated technologies in dental education. The findings revealed that technology was well accepted by students and was capable of providing the necessary training, with the exception that utilizing basic software was easier (15). Jalali et al. designed mobile application for dental education, and the results showed a significant increase in students' satisfaction and their final grades (16). Babazadeh et al. evaluated the impact of e-learning via smartphone in the practical course of oral pathology. According to the findings, mobile learning has a considerable impact on the students' final scores (13).

The use of educational application in dentistry is novel. A few educational technologies have been developed with the goal of teaching topics related to dentistry (16). Moreover, students explicitly stated their need for further software programs in order to be guided in clinical decision making (17, 18). Further studies are recommended to know which specific online learning method works (specifically within the domain of health sciences) and how online learning improves teaching (19). The aim of this research was to develop an educational web-based application for diagnosis in oral medicine and evaluation of students' attitudes towards it.

Methods

Study design: In this educational intervention, which involved one sample group, first the educational web- based application was designed based on the ADDIE instructional design model. Next, 30 dental students were selected by convenience sampling, and their attitudes toward the designed educational web- based application were assessed.

Participants

All 30 dental students in the 6th semester

who had enrolled in a first-grade practical oral medicine course during the September-December 2019 from Zanjan dental school participated in this study. These students voluntarily agreed to participate in the study and signed a written informed consent form. The exclusion criteria were students who eliminated the first-grade practical oral medicine course during the study; those who had already taken the first-grade practical oral medicine course the previous semester and had not received a passing score; and their unwillingness to follow the study.

Educational Interventions

Five steps of ADDIE instructional design model consisted of analysis, design, development, implementation, and evaluation (20).

Analysis: Dental students are the target group to use this educational product. Their educational need is to promote theoretical information on various topics that will help to make the correct diagnosis of oral lesions.

Design: The instructor organized the course materials and learning objectives based on the oral medicine course curriculum. Based on the relevant and updated resources and authoritative literature, the algorithm for the principles of examination, diagnosis, and management of oral normal variations and dental anomalies was created.

Development: This web-based application was developed using the asp. net web form framework and the #c programming language. Due to the need to store and recover the data, the Microsoft SQL Server database was used. Users can use this software to upload appropriate files and, if necessary, download and read them from the relevant database. The web-based application was tested once the programming procedures were completed. The software was then fine-tuned to produce the final version. Images for the program icons were similarly created in the Photoshop CS6 software environment and included in the final version of the web app. The software developed in this study was web-based, allowing users to access it from any type of electronic device, such as laptops, smartphones, and tablets.

Implementation: The name of this web-based application was Wise Dentistry Education System, abbreviated as WDES. Users could enter the web application environment by entering the www.Wisedes.ir domain. The web-based application was delivered to all 30 dental sixth-semester students in the September-December 2019. The web-based application was presented virtually in the form of uploads on the website for one month.

Evaluation

The web-based application was presented virtually in the form of uploads on the website for one month and the dental students' attitudes toward the web-based application were assessed.

Data Collection Tool

To determine the students' attitudes toward the educational web-based application, the researchers used a standard Kaplan educational product evaluation questionnaire developed in 2012 with a 5-point Likert scale ranging from strongly disagree (1 point) to strongly agree (5 points), with 36 items in 12 areas with 3 questions in each area (objectives, assessment, practice, examples, information, multimedia, overviews, integration, motivation, organization, usability, and personalization) (21, 22). The total score ranged between 1 and 5.

Validity and Reliability of Data Collection Tool

First, the translated questionnaire was given to 10 medical education specialists, and its content validity was validated by experts; no item was deleted. Both the Content Validity Ratio (CVR) and the Content Validity Index (CVI) were adequate because the CVR was 0.80 and the CVI was 0.91, which were higher than 62.5% and 79%, respectively. The reliability of the instrument was assessed by Cronbach's alpha of 0.89.

Statistical Methods

Statistical analysis was performed using IBM SPSS Statistics, version 26 (IBM Corp, ChicagoIL, USA). To describe the qualitative data, percentage and frequency were calculated, and to describe the quantitative data, the mean and standard deviation were calculated. Statistical significance was calculated for all the questionnaire's areas using the one sample t-test and the cut-off point of 3.

Ethical Considerations

All 30 students voluntarily agreed to participate in the study and signed a written informed consent form. This study was approved by the ethics committee in Zanjan University of Medical Sciences with the code of IR.ZUMS.REC.1397.279.

symbol with a distinct color associated with it (Figure 1). Appropriate and valid scientific sources on the issue of normal oral variations and dental anomalies were prepared from reference books and used in the web-based application for each of these areas.

In the thematic training area, the learner could read the text of the reference books combined with the applicable graphics (Figure 2). In the case-by-case training section, the student selects information on radiographic diagnostic features, clinical observations, and so on, and then answers clinical questions related to that information (Figure 3). Images from reference books with citations were included in the visual training part for normal oral variations and dental anomalies (Figure 4). In the training algorithm section, the chapters and titles related to the educational

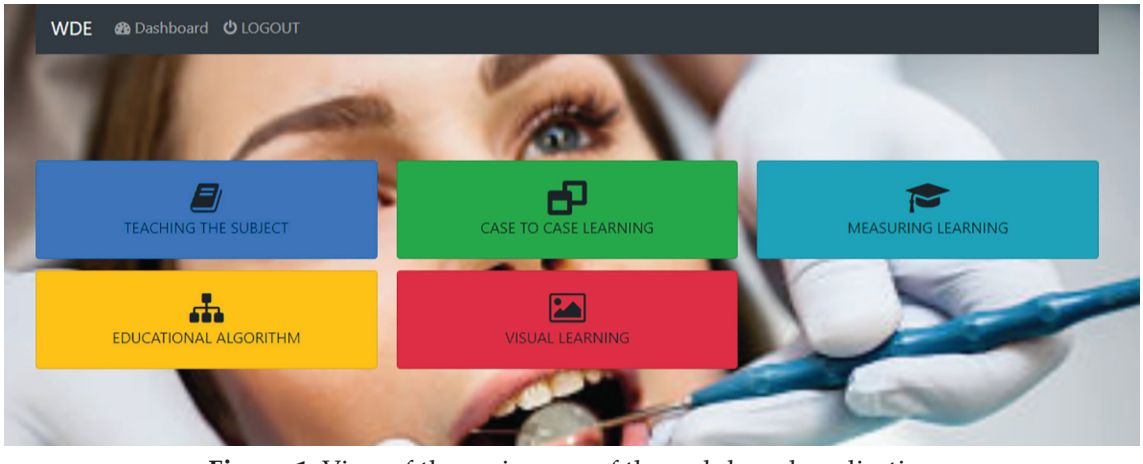

Figure 1: View of the main page of the web-based application

Results

Web-based Application Development

In the first stage, the web-based application was successfully developed. Five main options were provided in this program, including "thematic training," " case-by-case training," " visual training," "algorithm-based training", and "learning assessment." The main page of the web-based application is displayed after registering and entering the main page. The web-based application included five basic options: "thematic training," case-by-case training ", " visual training", "training algorithm," and "assessment of learning." Each of these icons was represented by a

Figure 2: View of the thematic training page

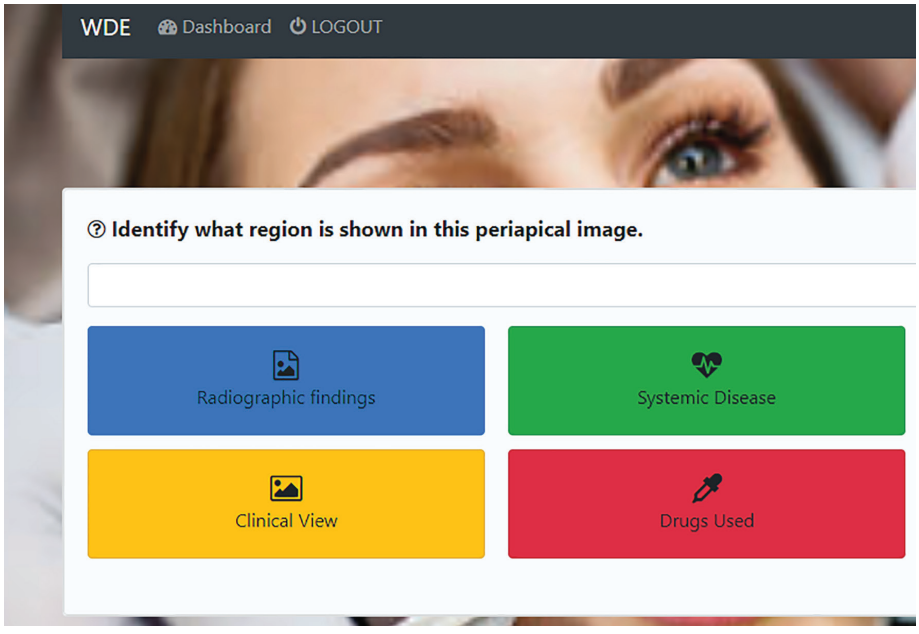

Figure 3: View of the case-by-case training page

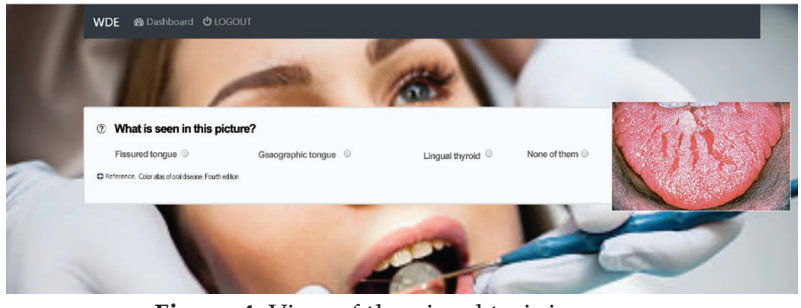

Figure 4: View of the visual training page

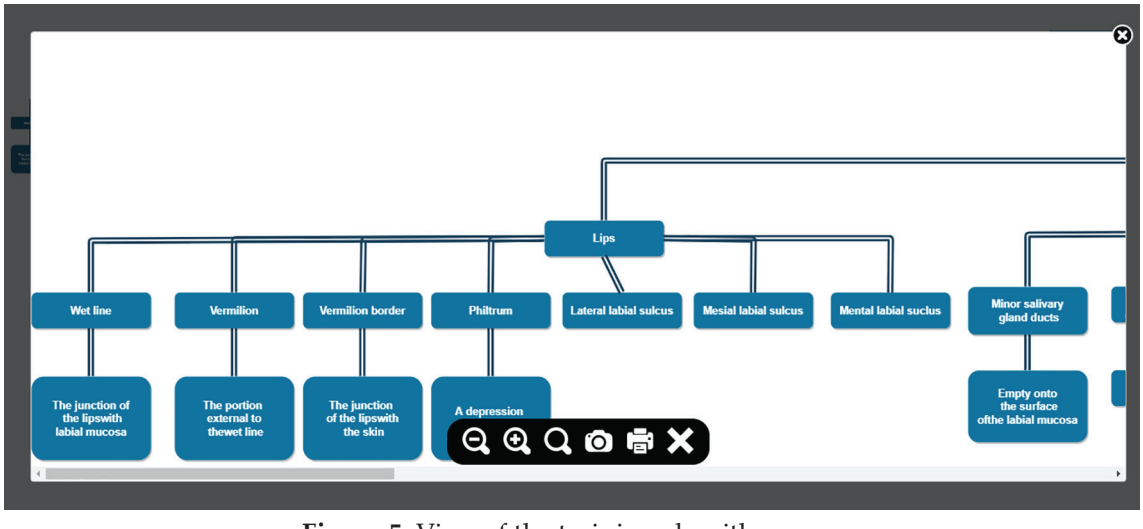

Figure 5: View of the training algorithm page

materials are depicted as tree diagrams. This tree diagram will help the student better understand the concepts (Figure 5). In the assessment phase, the student must answer the exam questions, and then he/she will receive feedback.

In the second stage, 30 dental students of 6th semester of Zanjan University of Medical Sciences, including 16 women and 14 men with a mean age of 21.69±0.70 and 21.78±0.69 years, respectively, participated in this study. The questionnaire had 12

domains including objectives, assessment, practice, examples, information, multimedia, overviews, integration, motivation, organization, usability, and personalization. Table 1 shows the mean values and standard deviations for each domain. Statistical significance was calculated for each of these areas using one sample t-test and the cut-off point of 3. It was found that all the areas were statistically significant (Table 1). The frequency (percent) reports for each question in the questionnaire using a 5-point Likert scale are presented in Table 2.

Table 1: The minimum, maximum, mean, and standard deviation for each questionnaire domains

Students' attitudes questionnaire domains	Minimum	Maximum	Mean	Standard Deviation	-value*
Objectives	3.00	6.00	5.60	0.89	0.0001
Assessment	3.00	6.00	5.57	0.90	0.0001
Practice	3.00	6.00	5.40	1.04	0.0001
Examples	3.00	6.00	5.67	0.80	0.0001
Information	3.00	6.00	5.30	0.88	0.0001
Multimedia	3.00	6.00	5.10	1.06	0.0001
Overviews	3.00	6.00	5.07	1.25	0.0001
Integration	3.00	6.00	4.77	1.13	0.0001
Motivation	4.00	6.00	5.70	0.53	0.0001
Organization	3.00	6.00	5.33	1.06	0.0001
Usability	3.00	6.00	5.83	0.65	0.0001
Personalization	3.00	6.00	4.83	1.34	0.0001

*Used one sample t- test

Table 2: The frequency (percentage) of students' attitudes for each question in the questionnaire

Criteria		Frequency (percent)				
		Strongly disagree	Disagree	No opinion	Agree	Strongly agree
1	Objectives					
1.1	Learning objectives are stated	0 (0%)	0 (0%)	2 (6.7%)	7 (23.3%)	21 (70%)
1.2	Learning objectives are stated as performance objectives	0 (0%)	0 (0%)	6 (20%)	7 (23.3%)	17 (56.7%)
1.3	Learning objectives are aligned	0 (0%)	0 (0%)	4 (13.3%)	9 (30%)	17 (56.7%)
2	Assessment					
2.1	Assessment matches objectives	0 (0%)	0 (0%)	2 (6.7%)	6 (20%)	22 (73.3%)
2.2	Assessment measures acquisition knowledge components.	0 (0%)	2 (6.7%)	4 (13.3%)	10 (33.3%)	14 (46.7%)
2.3	Detailed scoring guides are provided for constructed responses	0 (0%)	2 (6.7%)	3 (10%)	3 (10%)	22 (73.3%)
3	Practice					
3.1	Practice matches assessment	0 (0%)	0 (0%)	4 (13.3%)	6 (20%)	20 (66.7%)
3.2	Practice develops knowledge components.	0 (0%)	1 (3.3%)	3 (10%)	7 (23.3%)	19 (63.3%)
3.3	Feedback corrects errors and misconceptions.	0 (0%)	2 (6.7%)	8 (26.7%)	8 (26.7%)	12 (40%)
4	Examples					
4.1	Examples match practice.	0 (0%)	2 (6.7%)	0 (0%)	18 (60%)	10 (33.3%)
4.2	Demonstrations illustrate task performance.	0 (0%)	2 (6.7%)	2 (6.7%)	6 (20%)	20 (66.7%)

4.3	Examples illustrate knowledge components.	0 (0%)	2 (6.7%)	2 (6.7%)	18 (60%)	8 (26.7%)
5	Information					
5.1	Information matches knowledge components.	0 (0%)	0 (0%)	9 (30%)	7 (23.3%)	14 (46.7%)
5.2	"Nice to know" information is minimized.	0 (0%)	0 (0%)	4 (13.3%)	12 (40%)	14 (46.7%)
5.3	Important information is highlighted.	0 (0%)	0 (0%)	8 (26.7%)	6 (20%)	16 (53.3%)
6	Multimedia					
6.1	Text and corresponding graphics are positioned close together.	0 (0%)	0 (0%)	6 (20%)	17 (56.7%)	7 (23.3%)
6.2	Complex visuals are narrated, without redundant on-screen text.	0 (0%)	2 (6.7%)	10 (33.3%)	9 (30%)	9 (30%)
6.3	Multimedia presentations are segmented.	0 (0%)	0 (0%)	9 (30%)	12 (40%)	9 (30%)
7	Overviews					
7.1	Overviews are included.	0 (0%)	0 (0%)	8 (26.7%)	12 (40%)	10 (33.3%)
7.2	Overviews preview and review content and context.	0 (0%)	0 (0%)	8 (26.7%)	7 (23.3%)	15 (50%)
7.3	Overviews explain the value of the content.	0 (0%)	0 (0%)	12 (40%)	9 (30%)	9 (30%)
8	Integration					
8.1	Presentations make connections among knowledge components.	0 (0%)	0 (0%)	13 (43.3%)	5 (16.7%)	12 (40%)
8.2	Questions during presentation and practice promote self-explanation.	0 (0%)	0 (0%)	12 (40%)	8 (26.7%)	10 (33.3%)
8.3	Prompts for discussions promote explanation of knowledge components.	0 (0%)	0 (0%)	12 (40%)	10 (33.3%)	8 (26.7%)
9	Motivation					
9.1	Content difficulty is addressed to regulate confidence.	0 (0%)	2 (6.7%)	1 (3.3%)	21 (70%)	6 (20%)
9.2	Performance is attributed to effort.	0 (0%)	0 (0%)	4 (13.3%)	6 (20%)	20 (66.7%)
9.3	The tone is positive.	0 (0%)	0 (0%)	2 (6.7%)	16 (53.3%)	12 (40%)
10	Organization					
10.1	Content is organized by objective.	0 (0%)	0 (0%)	6 (20%)	10 (33.3%)	14 (46.7%)
10.2	Knowledge components are covered in prerequisite order.	0 (0%)	0 (0%)	5 (16.7%)	8 (26.7%)	17 (56.7%)
10.3	Content alternates between presentation and practice.	0 (0%)	0 (0%)	9 (30%)	14 (46.7%)	7 (23.3%)
11	Usability					
11.1	The product is easy to navigate.	0 (0%)	0 (0%)	2 (6.7%)	4 (13.3%)	24 (80%)
11.2	Location and progress are visible.	0 (0%)	0 (0%)	2 (6.7%)	2 (6.7%)	26 (86.7%)
11.3	Styles for format and functionality are consistent.	0 (0%)	0 (0%)	1 (3.3%)	7 (23.3%)	22 (73.3%)
12	Personalization					
12.1	Content is personalized.	0 (0%)	0 (0%)	11 (36.7%)	13 (43.3%)	6 (20%)
12.2	Guidance is personalized.	0 (0%)	0 (0%)	12 (40%)	13 (43.3%)	5 (16.7%)
12.3	Learner control is personalized.	0 (0%)	2 (6.7%)	10 (33.3%)	12 (40%)	6 (20%)

Table 3: The frequency (percentage) of students' attitudes for each question in the questionnaire (recoded to code 1: disagree and code 2: agree)

Criteria		Frequency (percent)	
		Disagree	Agree
1	Objectives		
1.1	Learning objectives are stated	2 (6.7%)	28 (93.3%)
1.2	Learning objectives are stated as performance objectives	6 (20%)	24 (80%)
1.3	Learning objectives are aligned	4 (13.3%)	26 (86.7%)
2	Assessment		
2.1	Assessment matches objectives	2 (6.7%)	28 (93.3%)
2.2	Assessment measures acquisition knowledge components.	6 (20%)	24 (80%)
2.3	Detailed scoring guides are provided for constructed responses	5 (16.7%)	25 (83.3%)
3	Practice		
3.1	Practice matches assessment	4 (13.3%)	26 (86.7%)
3.2	Practice develops knowledge components.	4 (13.3%)	26 (86.7%)
3.3	Feedback corrects errors and misconceptions.	10 (33.4%)	20 (66.6%)
4	Examples		
4.1	Examples match practice.	2 (6.7%)	28 (93.3%)
4.2	Demonstrations illustrate task performance.	4 (13.3%)	26 (86.7%)
4.3	Examples illustrate knowledge components.	4 (13.3%)	26 (86.7%)
5	Information		
5.1	Information matches knowledge components.	9 (30%)	21 (70%)
5.2	"Nice to know" information is minimized.	4 (13.3%)	26 (86.7%)
5.3	Important information is highlighted.	8 (26.7%)	22 (73.3%)
6	Multimedia		
6.1	Text and corresponding graphics are positioned close together.	6 (20%)	24 (80%)
6.2	Complex visuals are narrated, without redundant on-screen text.	12 (40%)	18 (60%)
6.3	Multimedia presentations are segmented.	9 (30%)	21 (70%)
7	Overviews		
7.1	Overviews are included.	8 (26.7%)	22 (73.3%)
7.2	Overviews preview and review content and context.	8 (26.7%)	22 (73.3%)
7.3	Overviews explain the value of the content.	12 (40%)	18 (60%)
8	Integration		
8.1	Presentations make connections among knowledge components.	13 (43.3%)	17 (56.7%)
8.2	Questions during presentation and practice promote self-explanation.	12 (40%)	18 (60%)
8.3	Prompts for discussions promote explanation of knowledge components.	12 (40%)	18 (60%)
9	Motivation		
9.1	Content difficulty is addressed to regulate confidence.	3 (10%)	27 (90%)
9.2	Performance is attributed to effort.	4 (13.3%)	26 (86.7%)
9.3	The tone is positive.	2 (6.7%)	28 (93.3%)
10	Organization		
10.1	Content is organized by objective.	6 (20%)	24 (80%)
10.2	Knowledge components are covered in prerequisite order.	5 (16.7%)	25 (83.3%)
10.3	Content alternates between presentation and practice.	9 (30%)	21 (70%)
11	Usability		
11.1	The product is easy to navigate.	2 (6.7%)	28 (93.3%)
11.2	Location and progress are visible.	2 (6.7%)	28 (93.3%)
11.3	Styles for format and functionality are consistent.	1 (3.3%)	29 (96.7%)
12	Personalization		
12.1	Content is personalized.	11 (36.7%)	19 (63.3%)
12.2	Guidance is personalized.	12 (40%)	18 (60%)
12.3	Learner control is personalized.	12 (40%)	18 (60%)

To evaluate the students' attitudes, 5-point Likert scale of the questionnaire was recoded to code 1 (disagree), which was made up of strongly disagree, disagree, and no opinion, and code 2 (agree), which was made up of agree and strongly agree. The frequency (percent) reports for each question in the questionnaire are presented in Table 3.

The majority of students had positive attitudes in all 12 domains of the questionnaire; objectives (86.7%) (P=0.0001), assessment (85.5%) (P=0.0001), practice (80%) (P=0.0001), examples (88.9%) (P=0.0001), information (76.7%) (P=0.001), multimedia (70%) (P=0.028), overviews (68.9%) (P=0.011), integration (59%) (P=0.144), motivation (90%) (P=0.0001), organization (77.8%) (P=0.003), usability (94.4%) (P=0.0001), and personalization (62%) (P=0.144) were greater than average and were acceptable. Despite the difference between the two domains (integration and personalization) with the average score, no statistically significant difference was seen.

Discussion

The purpose of this study was to develop a web-based application for diagnosis in oral medicine and evaluation of the students' attitudes towards it. According to the findings, the majority of the students had positive attitudes regarding designed educational web-based application in all 12 domains of the questionnaire, which was statistically significant. Several studies have indicated that using virtual education can improve the quality of dental education or provide a quality comparable to traditional approaches (23-25). The employment of numerous materials such as images, videos, and educational animations appears to increase the students' engagement in the course, boost active learning, and hence improve the quality of education (14). As a result, in this study, we attempted to incorporate instructive graphics and videos into the design of educational software. According to the Walmsley's study, students and instructors had different perspectives on the use of the Internet in classroom instruction. Furthermore, students cited the cost, time, and method of using the Internet and computers as limitations and obstacles to using the Internet in education (26). It should be mentioned, however, that the Internet has grown considerably more accessible to students and instructors over time, and its use has become easier. Using the Internet has also become less expensive over time. As a result, it appears that using the Internet for education can be extremely beneficial (27). Alizadeh et al.'s study concluded that, similar to the traditional method, multimedia-based teaching resulted in students' positive reactions to the instruction and course (23). This is in line with the findings of the present study. According to Al-Taweel et al., satisfaction with technology-based education is moderate to low, which is not in the same line with the findings of this study (28). Barsuk et al. showed that learning through e-learning can remain in the learner's mind for longer periods of time (29). Given that dentistry is an experimental field in which the transfer of expertise from professors to students is critical, the use of various virtual education tools, such as the design of online virtual education software used in this study, can improve the quality of education. Various software programs have been used to provide teaching dentistry. Most of these software packages have a complex structure that includes a large amount of scientific content. However, the results of some studies have shown that the use of simple software has more useful educational outcomes (15). Therefore, in the present study, a software was designed that, in addition to conveying a substantial quantity of information, could also be utilized simply and easily. Another positive feature of educational software over printed books is the ability to easily search through thousands of pages of information and quickly find what you need (30). Furthermore, the web-based software could run on any device, including desktop computers, laptop computers, and even mobile phones. Such programs enable the user to repeatedly access information without concern for physical or

time limits (31, 32). These features were also available in the current software design. Some training software is based on invalid references. These programs, which are mainly published by unreliable publishers, raise concerns about their use (33). However, the software developed was based on valid dental references, and there was no scientific concern about its relevance to scientific studies.

Limitation and Suggestions

One of the limitations of the current study is the small number of participants; consequently, the authors suggest that more studies on the software application on a larger sample size should be conducted in the future.

Conclusion

The innovative educational software was successfully developed. The results revealed that students were extremely satisfied with the quality of the educational software. As a result, it can be effectively employed as a teaching aid when combined with conventional education.

Acknowledgment

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Authors' Contribution

R.N: conceptualization and study design, S.A: experimentation and data acquisition, F.K: statistical analysis, A.N: study design and preparing the manuscript.

Conflict of Interest: None declared.

Ethical Consideration

This study was approved by Zanjan University of Medical Sciences' ethics committee, with the Ethical Approval Code: IR.ZUMS.REC.1397.279. Each individual provided written informed consent to the researchers. Before the research, the researchers were adequately presented, and the participants were explained about the research objectives. Informed consent was obtained, and the participants had the option to withdraw at any time during the research. Finally, it should be mentioned that the participants were ensured of the confidentiality of the information supplied.

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