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Original Article

Designing and Building a Mobile Educational Software Application for the Laboratory of Morphology and Physiology of Medically Important Insects and Assessing Students' Satisfaction Levels

Alireza Zare Karizi[1], Leila Shirani-Bidabadi[2*], Abbas Aghaei-Afshar[2], Mohammad Amin Gorouhi[2], Neda Shirani-Bidabadi[3], Ismaeil Alizadeh[4], Majid Asadi-Shekari[5], Abolfazl Khodadadi-Bidokhti[6]

[1]Student Research Committee, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran
[2]Research Center of Tropical and Infectious Diseases, Kerman University of Medical Sciences, Kerman, Iran
[3]Department of Electrical and Computer Engineering, Isfahan University of Technology, Isfahan, Iran
[4]Department of Vector Biology and Control, Faculty of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[5]Neuroscience Research Center, Kerman University of Medical Sciences, Kerman, Iran
[6]Information Technology Unit, Gonabad University of Medical Sciences, Gonabad, Iran

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***Corresponding author:**
Research Center of Tropical and Infectious Diseases, Kerman University of Medical Sciences, Kerman, Iran.
Email: l.shirani@kmu.ac.ir

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Abstract

Background: As the new generation becomes increasingly drawn to technology, using mobile phone applications for education can enhance learning effectiveness.

Objectives: This study aims to design and create mobile-based software to learn about the morphology and physiology of medically important insects. It also investigates user satisfaction with this educational software.

Methods: This applied research was conducted using a developmental method consisting of two stages: designing and creating software for the Android operating system and evaluating the level of satisfaction through an electronic questionnaire administered to 56 biology and disease vector control students. The statistical tests used in this project included the Mann-Whitney test, the Kruskal-Wallis's test, and the independent samples t-test.

Results: There was no significant difference between the genders of the students in their responses to the graphics, educational content, and overall grades. There was also no significant difference between the students' entry year and their responses in the graphic and educational sections or their total scores. Similarly, no significant difference was observed between the age groups of the students in their responses to the graphic test, educational content, and total score (P-value = 0.576, P-value = 0.923).

Conclusion: This software comprehensively covers topics related to the morphology and physiology of medically important insects and disease vectors. It provides information on organism identification and methods of combating them, making it useful for students and researchers.

Keywords: Morphology; Physiology; Software; Mobile Applications

Background

Studying biology and controlling disease vectors are essential for understanding and combating insects that transmit diseases. In Iran, this field has gained considerable attention due to the significance of vectors, highlighting the need to train specialists to address and manage these health threats effectively. This research focuses on key medical insects that carry serious diseases affecting humans. In recent years, the threat of epidemics, such as dengue fever, Zika, and yellow fever, among others, has underscored the necessity for software that enhances our understanding of the morphology and physiology of vectors. This comprehensive software will cover topics related to the morphology and physiology of medically significant insects and disease vectors, aiding students and

researchers in identifying these organisms and exploring control methods. The COVID-19 pandemic has hindered practical and laboratory instruction across various courses, resulting in increased insect phobias and limited laboratory resources. Unique features of the proposed software include a focus on medically important insects, mobile access, slides and photos of vectors, and assessments of student satisfaction.

We plan to add detailed laboratory courses to our website and application to address these challenges. This interdisciplinary approach, combining biology, disease vector control, and computer engineering, aims to enhance teaching for professors and learning for students while ensuring equitable access to education. If successfully implemented, the initiative will provide professors and students with extensive information on the morphological and physiological traits of important medical insects. The insect morphology and physiology course are a core component of biology and disease vector control programs, where professors and students examine external and internal insect structures. This course includes a laboratory unit facilitating a deeper understanding through practical experiences. In the lab, insects are analyzed more accurately under microscopes and controlled conditions, making hands-on learning essential to this subject. Laboratory experience is crucial for technical and scientific education (1). The development of human societies in various areas, along with the growing demand for new and diverse information, has led to a strong dependence on the flow of timely information. Access to this information is vital in all fields. In this information age, it is natural that the telecommunications and communication technology industries have experienced significant growth. Among these industries, mobile phone services have shown some of the highest growth rates. They are increasingly vital in daily communication and are expected to surpass landline services. Mobile and Internet learning can partly fulfill the idea of learning anytime and anywhere. Mobile learning, a branch of e-learning, allows learners to access educational content more easily than other forms of e-learning. This ease of access is made possible by the extensive communication and interactive features of the devices and tools used in online learning. Learning through mobile phones improves learner satisfaction, encourages autonomy, supports interactive enrichment, and facilitates effective communication activities. Mobile learning, which involves using mobile devices in the teaching and learning process, enables education without time and location limitations, promoting mobility and optimal connectivity. It broadens opportunities for formal and informal education, breaking geographical barriers and accommodating different levels of understanding. Among various mobile learning tools, mobile phones play a key role as a wireless technology transforming education and contributing to the democratization of learning due to their widespread usage. Another emerging educational approach is electronic education (e-learning), which includes a range of software applications and teaching methods based on information technology, such as computers, CDs, networks, the Internet, and intranets. It allows learners to learn anytime and anywhere, tailored to their individual strengths. The idea of virtual laboratories has been proposed to cut costs and simplify laboratory facilities. These virtual labs give students access to real systems (2). This need is particularly important when considering the potential use of virtual laboratories (vLABs) to prepare students for laboratory exercises. These virtual labs can act as an alternative to in-person training, reducing the time and resources needed. Various computer-based technologies are currently being used to enhance training practices. The traditional educational model differs significantly from the hands-on laboratory environment. Research has shown that using educational videos before laboratory exercises effectively standardizes teaching and improves outcomes in later lab work. The main aim of developing a web-based virtual laboratory is to give students access to various science and engineering education experiments through the Internet. This is especially helpful for geographically dispersed students, such as those who study from home. The virtual lab operates on the principles of distance education, allowing students to learn from remote locations without needing to attend the university in person. Within the web-based virtual lab, students can participate in theoretical exercises, access past tests, and review test content. This approach uses programming languages like Java, VRML, and MATLAB (3). However, traditional face-to-face labs come with numerous drawbacks, as supported by extensive studies indicating that these issues are prevalent across various courses and disciplines. We can achieve more comprehensive and effective outcomes by integrating these two teaching methods (3). Since the educational materials will be available online, researchers and interested individuals in Iran and beyond can access the resources and facilities offered by the website and application.

Objectives

Considering the importance of virtual labs in educational science, this study aims to design and

develop mobile-based software for learning about the morphology and physiology of medically important insects. It also investigates user satisfaction with this educational software.

Methods

Study Design and Demographic Characteristics: The present study was a descriptive cross-sectional research project conducted in three stages: assessing software needs, designing and developing the software, and evaluating its effectiveness. The first stage involved designing and creating mobile-based educational software for the morphology and physiology of medically important insects using the Android operating system. The second stage included conducting a questionnaire study to assess user satisfaction and the usefulness of the educational software.

The software development process for this research involves four stages:

1. Designing the basic software template.
2. Gathering data and information related to the morphology and physiology of medically important insects.
3. Entering the collected data into the software.
4. Finalizing the software design and summary.

In the first step, we designed the initial software template and coded the basic Android programming software. For programming, we used Android's internal database, known as the second database. The software overview was created using the Java programming language, and this educational software was developed with Android Studio version 2021.1. To optimize the software production process, the text and images were stored in an SQLite database in Android, which is loaded when the program is executed.

In the second step, we gathered scientific information on the morphology and physiology of medically significant insects from books, websites, and internal and external reference guidelines.

The third step involved entering the collected information into the software's raw format, with the contents of each section entered separately.

In the fourth step, we finalized the software design, which is compatible with the Android system and can be installed on mobile phones for student use. Various software components, including scientific content, images related to insect morphology and physiology, and essential medical arthropods, were selected, modified, and approved by biology and disease vector control experts, who are this study's authors. Due to the small number of undergraduate students, the sample size was calculated through a census. Convenience sampling was used as the sampling method. The data collection tool for this stage was a questionnaire made available to all undergraduate students, laboratory experts with a master's degree, and individuals with a specialized doctorate in biology and disease vector control. A total of 56 participants completed the questionnaire.

Tool Development Phase: The scientific content for the educational software was sourced from reputable scientific publications and specialized books. All the educational images and photos used in the software were obtained from reliable sources, such as the World Health Organization and Google.

A web-ready framework called Joomla (Joomla CMS) was utilized to build a database efficiently and effectively. In this method, the data is registered in the management panel of the web-based software, extracted from the server-side database, undergoes minor modifications, and then prepares the relevant database file for injection into the Android application.

Implementation Phase: After installing the software, users were invited to participate in this study. They were asked to complete an electronic questionnaire carefully, and finally, information related to each user was collected. The software programming team designed and implemented this unique process.

Evaluation Stage: The second stage of this descriptive cross-sectional study was conducted in 2023 with 56 participants, including undergraduate students of biology and disease vector control, laboratory experts, and professors at Kerman University of Medical Sciences. This stage aimed to measure their satisfaction with the software.

The electronic questionnaire used in this study was adapted from Alizadeh et al.'s study conducted in 2018 and 2019 (4-6). In the second data collection stage, the participants completed the electronic questionnaire to measure their level of satisfaction. The questionnaire was specifically designed for this study with some modifications based on Alizadeh et al.'s study on mobile phone-based software for the identification, prevention, and control of head lice and health pest software among biology and vector control students at Jundishapur University of Medical Sciences in Ahvaz (7). The initial study was conducted with the presence of 20 students in the field of biology and disease vector control. Two experts in the field of biology and disease vector control and two experts in the field of statistics confirmed the validity and reliability of the questionnaire. Furthermore, its reliability was confirmed by conducting a preliminary study with a Cronbach's alpha index of 0.85. The questionnaire included demographic

questions such as age, sex, education level, and entry year. It also contained 12 open-ended questions regarding the graphical capabilities of the software, rated on a Likert scale with five options (I completely agree, I agree, I disagree, I completely disagree, I have no opinion). Additionally, there were seven open-ended questions about the educational capabilities of the software, which were also rated on a Likert scale with the same five options.

Data Analysis Method: After the users completed the questionnaires, the data were entered into SPSS software version 27 and analyzed using descriptive statistical indicators. First, the raw data were checked for normality with the Shapiro-Wilk test. An independent sample t-test was used to compare graphic and educational scores in normal data distributions, and the Mann-Whitney test was used to compare non-normal distributions of scores. The Kruskal-Wallis's test was used to compare the scores of different student entries.

Ethical Consideration: Ethical considerations were taken into account, and the participating students were assured that their information would remain completely confidential and that their names and surnames would not be mentioned. The study provided a code for anonymity. This research is part of a project approved by the Student Research Committee affiliated with the Vice-Chancellor of Research and Technology of Kerman University of Medical Sciences in Iran. The grant number for the project is 400000613.

Results

Instrument Characteristics: In this research, a mobile-based educational aid software called "Laboratory of Morphology and Physiology of Medically Important Insects" was developed and designed for mobile phones. The software is compatible with the Android system and can be installed on mobile phones. Appendix 1-A-D displays the final images of the developed software, showing different screens.

The program's logo page opens after clicking on the program icon installed on an Android mobile phone. The top of this page displays the name of Kerman University of Medical Sciences, along with the name of the "Insect Morphology" software (Appendix 1-A). On this page, three options are available: enter the encyclopedia, learn about us, and contact us (Appendix 1-A).

Clicking on the encyclopedia menu on the second page opens three main menus: insect morphology, insect physiology, and medically important arthropods. Selecting the insect morphology menu opens sections on tentacle shapes, different types of legs, mouthparts, and wings in insects.

The corresponding description opens when clicking on each main part of the software. Clicking on the insect physiology menu provides access to menus about the nervous, circulatory, respiratory, digestive, excretory, vision, and reproductive systems. To continue using the software, the 'Medically Important Arthropods' menu should be selected to display a list of these arthropods with their respective images, including spiders, scorpions, and medically important insects. After clicking on each group of medically important arthropods, a page opens. This page includes descriptions of the morphology, biology, and life cycle, as well as the order, family, and different species of that group. An image is also provided next to the species name (Appendix 1-B).

The list of medically important insects includes mosquitoes, gnats, butterflies, blister beetles, Simuliidae, bees, Culicine, Anopheline, myiasis, family Muscidae, Fanniidae, bed bugs, lice, cockroaches, and fleas. After clicking on each of these, a page opens that provides explanations related to morphology, biology, life cycle, and the order, family, and different species of that group. An image is also provided next to the species name (Appendix 1-C, D). Lastly, a page titled 'Contact Us' is presented to receive any criticisms or suggestions from users. Through this page, users can communicate with the creators of the program (Appendix 1-A). The communication methods with the creators include email, WhatsApp, Telegram, and Instagram, managed by the main developer of the software.

Software evaluation results: To evaluate the educational and graphic capabilities of the designed software, 56 students from the first, second, third, and fourth years of biology and vector control, along with experts and professors from the Department of Health at Kerman University of Medical Sciences, participated.

Demographic Information of the Participants: Table 1 lists the results related to the demographic information of the survey participants regarding their degree of satisfaction with the software and shows the demographic information of the software users.

The users suggested adding videos related to the morphology and physiology of insects, using higher quality and higher resolution photos, and creating an installable version of the software. In addition, the software was not installed on mobile phones with Android operating system version 13 or higher for some users due to either the low Android version of their mobile phones or the high version of Android.

Satisfaction of the Students: The survey results on the students' level of satisfaction regarding the graphic and educational capabilities of the contents of the educational software are reported in Table 2.

According to the results of this study, more than 75% of the users mentioned that the software was easy to install. In addition, 85.7% of the users believed that the information provided in the software was up-to-date. This research showed that 98.2% of the users found the software easy to use. The evaluation results regarding the software's educational capabilities in identifying the morphology and physiology of medically important insects are reported in Table 3.

A total of 94.6% of the users believed that the software provided the required information regarding the morphology and physiology of insects. Moreover, 92.9% of the users felt that the designed software enhanced their knowledge, attitude, and performance related to insect physiology and morphology. In addition, 87.5% of the users found the scientific content up-to-date, while 76.8% believed that the software would benefit from including more information that is specialized. Furthermore, 75% of the users preferred using this software to books when seeking information about insect morphology and physiology.

Table 1 presents the demographic information of the survey participants and their level of satisfaction with the software. The results indicated that 80.4% of the participants were female, while 19.6% were male. Regarding age, 12.5% were in the 10-20 years range, while 83.9% were in the 20-30 years range. Furthermore, fourth-year students from this university made up 23.2% of the participants. Among the participants, 94.6% were undergraduates, 3.6% were pursuing a master's degree, and 1.8% held a PhD.

Refer to Table 1 for a comprehensive overview of the demographic information.

The users provided suggestions for enhancing the software, including adding videos on insect morphology and physiology, using higher quality and resolution photos, and developing an installable version. Some users also reported issues with installing the software on Android phones with version 13 or higher, which could be attributed to either their phone's lower Android version or the software's compatibility with higher Android versions. Table 2 presents the survey results regarding students' satisfaction with the graphic and educational capabilities of the software content. According to the findings, over 75% of the users found the software installation process easy. Additionally, 85.7% of the users expressed that the information provided in the software was up-to-date. Furthermore, the research revealed that 98.2% of the users actively utilized the software. A detailed overview of the users' satisfaction levels is provided in Table 2.

Table 3 reports the evaluation results of the software's educational capabilities in identifying the morphology and physiology of medically important insects. The findings indicated that 94.6% of the users believed the software adequately provided the required information on insect morphology and physiology. Moreover, 92.9% of the users reported that the software improved their knowledge, attitude, and performance about insect physiology and morphology. Regarding the scientific content, 87.5% of the users found it to be up-to-date. However, 76.8% of the users desired more specialized information within the software's content. Additionally, 75% of the users preferred using the software to books when seeking information on insect morphology and physiology.

Table 4 shows the students' satisfaction scores for the graphic and educational capabilities and the total score of the students' answers to the questionnaire items. The Mann-Whitney statistical test indicated no significant difference between the genders of the students and their graphic, educational, and overall grades (Table 5). The Kruskal-Wallis statistical test showed no significant difference between the students' entry year and their responses in the graphic and educational sections or their total score (Table 5). Furthermore, the independent samples t-test showed no significant difference between the age groups of the students and their responses in the graphic test (Table 5). The Mann-Whitney statistical test also showed no significant difference between the age groups of the students and their responses in the educational section or their total score ($P = 0.576$, $P = 0.923$) (Table 5).

Discussion

The software developed in this study aims to teach biology students about disease vectors and their control.

Comprehensive software includes materials and photos related to the morphology and physiology of medically important insects. This software is designed to help students and researchers identify these organisms and learn about methods of combating them. It is mobile-based software, the first of its kind developed in Iran that assists students and laboratory experts in understanding and examining the morphological and physiological characteristics of medically important insects. The results of this study demonstrated that using educational software positively affected the students' learning. Accordingly, 92.85% of the students reported that the information provided by this educational

software increased their knowledge, attitude, and performance, as well as that of other users. In recent years, health and medical care have significantly grown with the help of mobile phone technology and software. This is because it is affordable and accessible for all users. For example, programs available for dental and oral health care can be accessed through mobile phones. Additionally, virtual training programs are specifically designed to help pregnant mothers with childbirth preparation (8-10). This study aims to develop and assess a comprehensive educational software application called Najbam, specifically designed for environmental health engineering students. This smartphone-based software aims to teach the proper techniques for disinfecting fruits and vegetables. By implementing and utilizing this software, we can enhance environmental health engineering students' educational experience and knowledge (11). In 2009, Wolf and colleagues conducted a study to evaluate the effectiveness of virtual laboratories for student learning (1). It is important to determine whether these virtual labs continue to impact student learning positively. The study's author assessed a computer-networking course to measure the learning that occurs during both lectures and lab sessions. The results showed that students learned during lab sessions, but a significant amount of learning (45.9%) also occurred during lectures, accounting for 54.1%. Notably, even students with previous experience in networking benefit from participating in virtual labs (1). In 2007, Wang discussed different technologies related to virtual laboratories and presented the technical structure and some project outcomes (3). The topic of virtual labs in science education has become increasingly important due to the rising costs of hands-on laboratories and the expansion of distance learning. Recent studies have examined how virtual tools can complement traditional lab experiences rather than replacements. Hawkins et al. (2013) conducted a study to evaluate the effects of virtual lab methods and ensure the effectiveness of conventional approaches. They compared a virtual lab scenario with a practical one in an electrochemistry class involving general chemistry students. Half of the students participated in the traditional lab format, while the other half used a virtual lab animation provided by the Iowa State Department of Education. The researchers collected pre-test and post-test data to measure the students' conceptual understanding and practical skills in setting up an electrochemical cell. The results showed no significant differences in scores between the two groups on the pre-test, post-test, or practical adjustment test. However, a notable difference emerged in specific test items, particularly concerning using the salt bridge during the post-test and practical setup (12). In their review of research on school science laboratories that employ simulation technology, Wang et al. (2014) found that simulations were often utilized as a precursor to physical lab work. Simulations enhance their learning and performance by introducing students to basic concepts and principles before they enter the physical labs. These simulations support students' understanding and boost their motivation to learn and improve their competence in self-assessment (13). Similarly, Wheeler (2012) noted an increase in students' perceived competence in the subject matter following a simulation-based training workshop, with students rating the workshop highly (2). In a literature review, Smetana and Bell (2012) concluded that, depending on their application, simulations could be as effective, if not more so, than traditional teaching methods. Simulations are recommended as supplementary tools alongside other educational methods (14). In 2020, Alizadeh et al. developed a mobile-based educational software to identify key health pests. The study showed that using this software positively affected student learning, with over 90% of students reporting enhanced knowledge, attitudes, and performance as a result (4). In 2019, Alizadeh et al. developed a specialized mobile application focused on bed bugs, one of the common health pests (5). The results of their study showed that user satisfaction with the bed bug mobile software was over 80% (5). Users also reported that the educational and practical information provided by the software had a positive impact, with over 78% acknowledging its usefulness (5). In 2020, Alizadeh et al. developed the first mobile-based software in Iran for identifying, preventing, and controlling sanitary pests (4). The study's findings revealed that the use of this educational software had a positive impact on students' learning. Over 90% of students reported that the software's information increased their knowledge, attitude, and performance, as well as that of other users (4). In a 2014 study by Ghazi-Saeedi and colleagues, over 82% of caregivers of children with cerebral palsy expressed satisfaction with the software developed in the study, stating that it met their information needs (15). Our study findings align with these results. In 2018-2019, Alizadeh et al. developed a mobile phone-based software for identifying, preventing, and controlling head lice. The study investigated the level of satisfaction among users of this educational software. The study's results showed that users of the mobile phone-based software

were highly satisfied. Over 60% of users found the information helpful in addressing head lice infestation (7). Additionally, more than 95% of users understood the scientific content of the software and considered it up-to-date (7). Most users (78%) reported that the educational information in the software effectively prevented and controlled lice infestation. Furthermore, approximately 81% of users preferred using this software instead of studying specialized texts during head lice infestation. They also reported a high level of effectiveness in controlling head lice through the educational information provided by the software (7). These findings are consistent with the present study. Safdari et al.'s study in 2017 also found that users of a developed software application for tuberculosis were satisfied, aligning with the results of the present study (16). Nasiri et al.'s study in 2013 investigated the effect of teaching anatomy through cell phones compared to lectures (17). The results indicated that teaching via cell phones improved learning and memory among medical students, with a particular emphasis on memorization (17). The present study found a preference for mobile phone-based education over traditional texts. Several other studies, including those by Nazari et al. in 2018 (18), Habibzadeh et al. in 2013 (19), and Papzan et al. (20), have reported similar results. Sarani and Ayati's study in 2013 (21) demonstrated high student satisfaction in learning English through mobile phones and combining this method with other educational approaches. Students also expressed high satisfaction in learning specialized subjects through mobile apps. Afkhami Aghda et al.'s study in 2013 (22) highlighted the significant impact of information and communication technology, including mobile apps, on education and social relations.

The images used in this mobile application adhere to Islamic norms. Additionally, the application includes content sourced from reputable books and authoritative references. By using this software, students can gain a thorough understanding of the morphology and physiology of significant insects in medicine. They can also virtually familiarize themselves with the laboratory unit of their course. Furthermore, since the application is designed to be presented as a website, interested individuals and researchers within and outside Iran can access the resources and facilities offered by this website and application. The limitations of the software include its size when installed on a mobile phone, the selection of scientific materials related to insect morphology and physiology, the collection of insect photos, the Preparation of photos featuring dried insect samples, and the preparation of photos of insect slides. We also faced limitations related to small sample sizes and convenience sampling. It is suggested that the software be developed into a more comprehensive and improved website, which can be made accessible to students of other medical science universities.

Conclusion

The present study found that the students were satisfied with the mobile app as a form of mass communication. Overall, the findings of this study and previous research demonstrate the positive reception and effectiveness of mobile phone-based educational software in various fields.

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Conflict of interests: There is no conflict of interest.

Ethical approval: The current research has the ethics approval code number IR.KMU.REC.1400.568. In this study, the users, including students and expert colleagues of the laboratory, voluntarily participated after receiving the necessary explanations about the study and its objectives and after being assured of the confidentiality of their information.

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Table 1. The Demographic Information of Software Users from Kerman University of Medical Sciences in 2023

Demographic information	Number (percentage)
Gender	
Male	11(19.6)
Female	45(80.4)
Age group	
10-20	7(12.5)
20-30	47(83.9)
30-40	1(1.8)
40-50	1(1.8)
Education level	
Bachelor of sciences (BSc)	53(94.6)
Masters (MSc)	2(3.6)
PhD	1(1.8)

Table 2. Evaluation Responses on the Software's Graphical Capabilities in Identifying the Morphology and Physiology of Medically Important Insects at Kerman University of Medical Sciences in 2023

Questions	I totally agree	I agree	I disagree	I totally disagree	I have no opinion
	Number (percentage)				
Installing the mobile phone is a straightforward process.	26(46.4)	25(44.6)	3(5.4)	1(1.8)	1(1.8)
The software's memory usage is optimized for the phone's storage capacity.	23(41.1)	29(51.8)	2(3.6)	0	2(3.6)
The software is user-friendly.	33(58.9)	22(39.3)	1(1.8)	0	0
The graphic components, buttons, and colors used in the software is appropriate.	14(25)	34(60.7)	6(10.7)	1(1.8)	1(1.8)
The software's graphic components, buttons, and colors are well chosen.	26(46.4)	26(46.4)	3(5.4)	0	1(1.8)
Can the designed software allow users to navigate to the next or previous pages?	22(39.3)	28(50)	4(7.1)	0	2(3.6)
The software's pages and image quality are designed with clarity and transparency.	20(35.7)	33(58.9)	1(1.8)	0	2(3.6)
The fonts utilized in the software are suitable and easy to read.	25(44.6)	28(50)	1(1.8)	0	2(3.6)
The software information is categorized appropriately.	13(23.2)	26(46.4)	5(8.9)	3(5.4)	9(16.1)
Receiving user comments through the communication channels defined in the software is a straightforward process.	23(41.1)	25(44.6)	0	0	8(14.3)
Is the amount of internet consumption by the software appropriate when it is being used?	18(32.1)	30(53.6)	5(8.9)	0	3(5.4)
Was the information provided in the software up-to-date?	15(26.8)	27(48.2)	4(7.1)	2(3.6)	8(14.3)
Was it easy to communicate with the software developers?	38.38	49.54	5.20	1.05	5.83
Overall results (%)	26(46.4)	25(44.6)	3(5.4)	1(1.8)	1(1.8)

Table 3. Evaluation Responses Regarding the Educational Capabilities of the Software in Identifying the Morphology and Physiology of Medically Important Insects at Kerman University of Medical Sciences in 2023

Questions	I totally agree	I agree	I disagree	I totally disagree	I have no opinion
	Number (percentage)				
The software effectively caters to users' information needs regarding the morphology and physiology of insects.	28(50)	25(44.6)	2(3.6)	0	1(1.8)
Learning the material becomes easier with different images.	27(48.2)	22(39.3)	3(5.4)	1(1.8)	3(5.4)
The use of software enhances the ease of both learning and teaching.	24(42.9)	29(51.8)	1(1.8)	0	2(3.6)
The software that has been designed enhances users' knowledge, attitude, and performance regarding the physiology and morphology of insects.	24(42.9)	28 (50)	3(5.4)	0	1(1.8)
The software's scientific content is current.	22(39.3)	27(48.2)	2(3.46)	0	5(8.9)
The software needs to incorporate a greater amount of specialized information in its content.	13(23.2)	30(53.6)	3(5.4)	0	10(17.9)
When I need information on insect morphology and physiology, I prefer using this software to a book.	13(23.2)	29(51.8)	6(10.7)	3(5.4)	5(8.9)
Overall results (%)	38.52	48.47	5.10	1.02	6.9

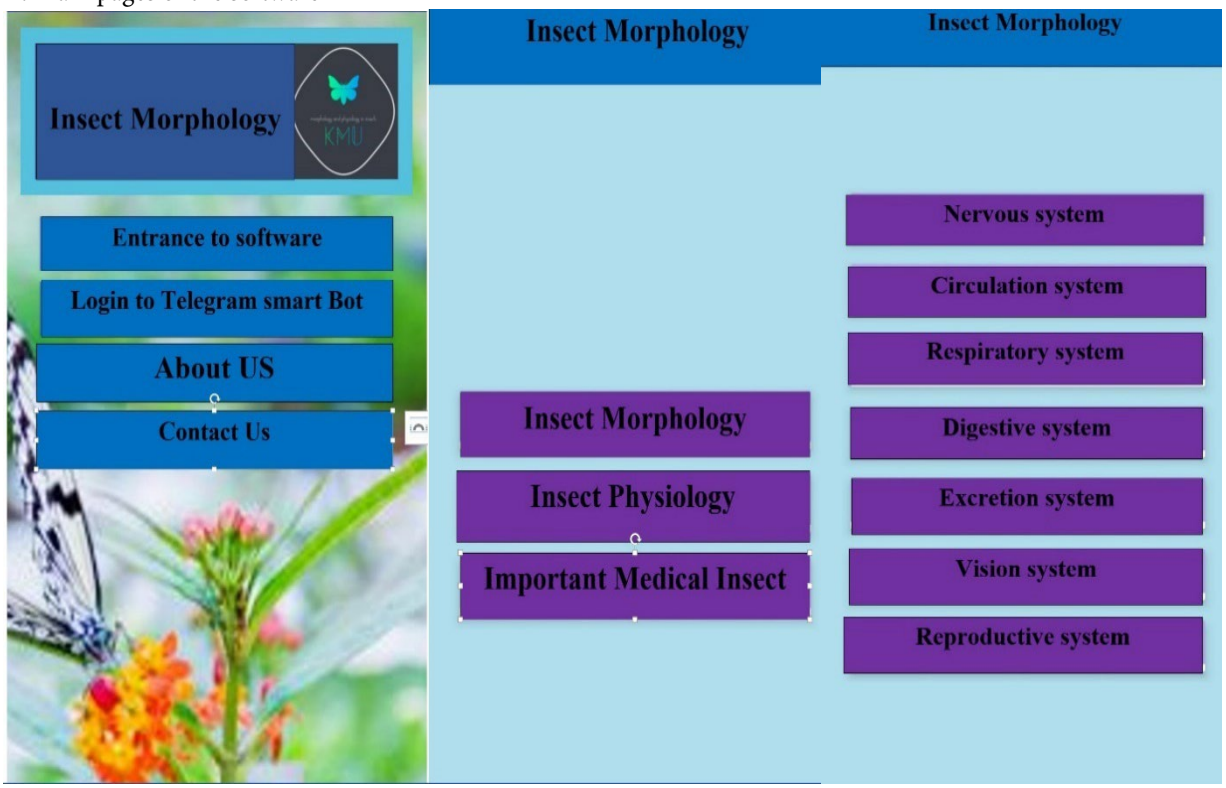
Table 4. Comparing the Results of Assessing the Graphic and Educational Features of the Software Studied Within the Target Group

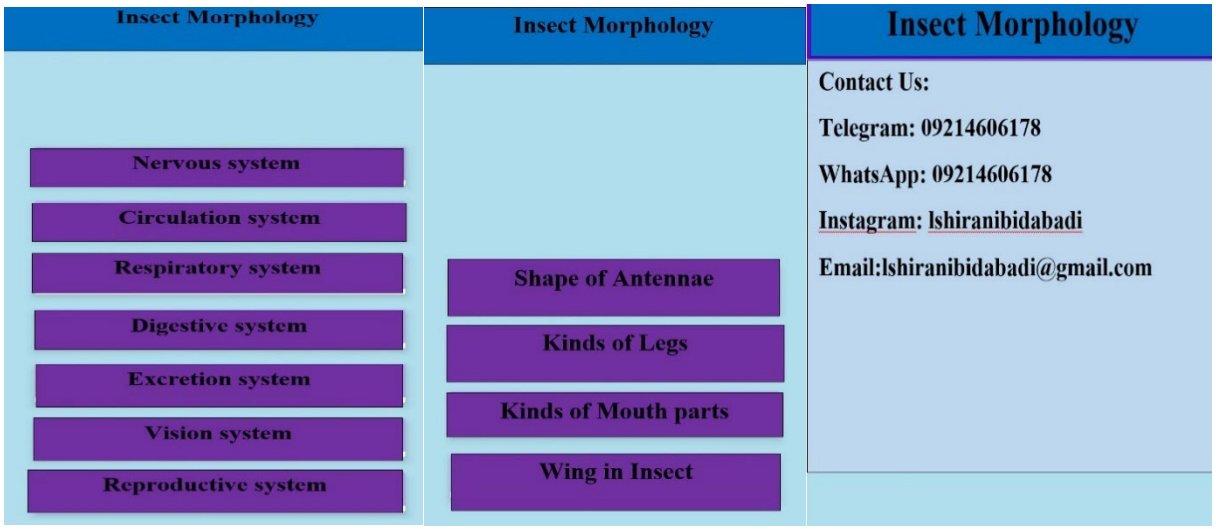
Score	Mean	Standard Deviation	Median	Percentile 25	Percentile 75
Total. Score	79.57	8.25	79.00	76.00	85.00
Train. Score	29.29	3.88	29.50	28.00	32.00
Graphic. Score	50.29	5.14	50.00	48.00	54.50

Table 5. Investigating the Impact of Demographic Factors on Students' Graphic and Educational Capabilities with the Software

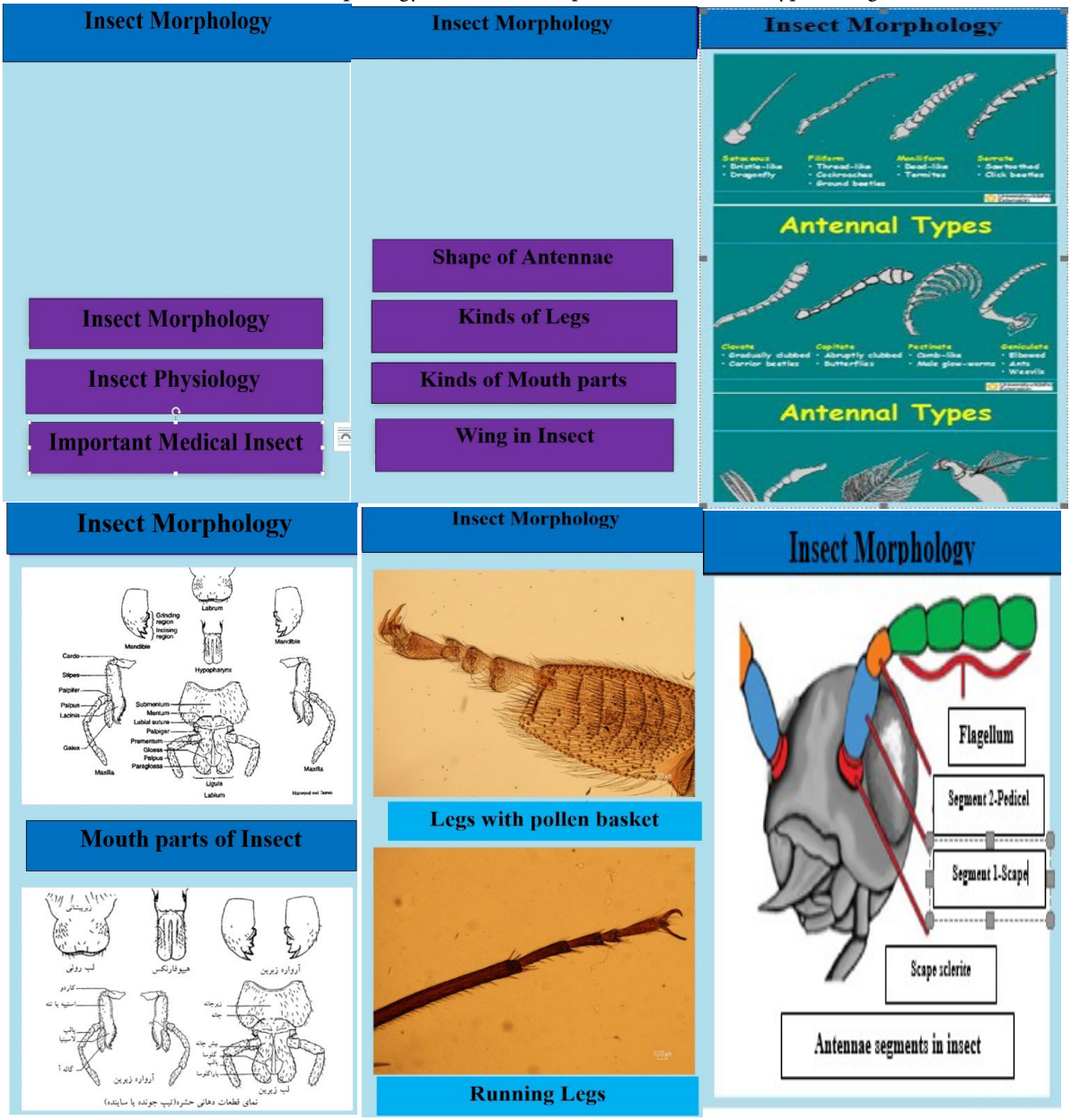
			Mean	Standard Deviation	Median	Percentile 25	Percentile 75	P-value
Total. Score	Sex	Female	79.71	8.11	79.00	76.00	85.00	0.901
		Male	79.00	9.19	79.00	73.00	85.00	
Train. Score	Sex	Female	29.51	3.85	30.00	28.00	32.00	0.333
		Male	28.36	4.06	28.00	24.00	32.00	
Graphic. Score	Sex	Female	50.20	5.06	49.00	48.00	54.00	0.605
		Male	50.64	5.70	50.00	49.00	57.00	
Total. Score	Age 1	10-20	80.43	4.35	80.00	77.00	84.00	0.923
		20-40	79.45	8.69	79.00	76.00	85.00	
Train. Score	Age 1	10-20	30.14	2.04	29.00	29.00	33.00	0.576
		20-40	29.16	4.07	30.00	28.00	32.00	
Graphic. Score	Age 1	10-20	50.29	3.30	48.00	48.00	54.00	0.319
		20-40	50.29	5.38	50.00	48.00	55.00	
Total. Score	Entrance	1399	81.38	7.82	84.00	79.00	87.00	0.204
		1400	81.33	6.54	77.00	76.00	87.00	
		1401	75.19	11.01	77.00	70.00	83.50	
		1402	81.27	4.54	80.00	77.00	85.00	
Train. Score	Entrance	1399	30.38	3.38	31.00	30.00	32.00	0.219
		1400	29.75	2.38	28.00	28.00	31.50	
		1401	27.31	5.64	28.00	22.50	32.50	
		1402	30.07	2.09	29.00	28.00	32.00	
Graphic. Score	Entrance	1399	51.00	5.20	52.00	46.00	55.00	0.391
		1400	51.58	4.23	49.00	48.00	55.50	
		1401	47.88	6.70	49.00	43.00	51.50	
		1402	51.20	3.00	51.00	48.00	54.00	

A. Main pages of the software

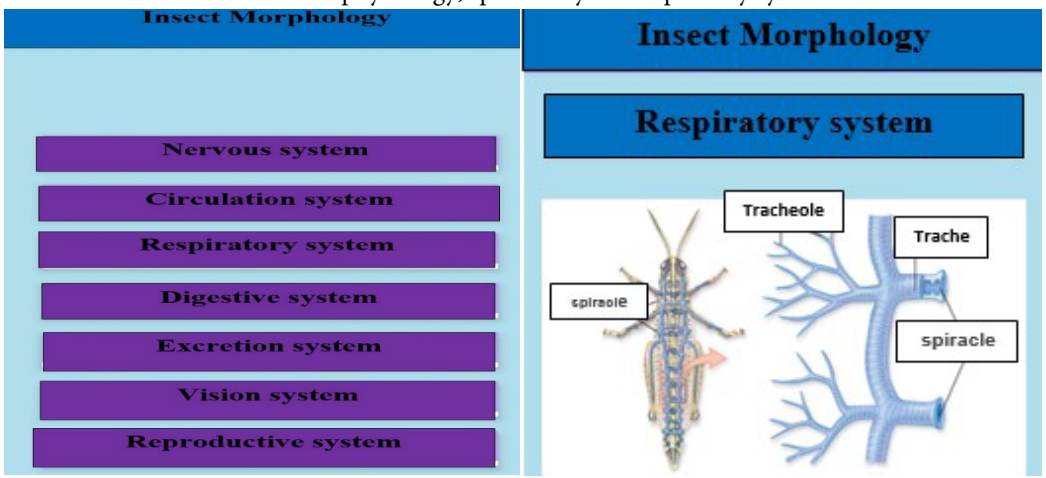




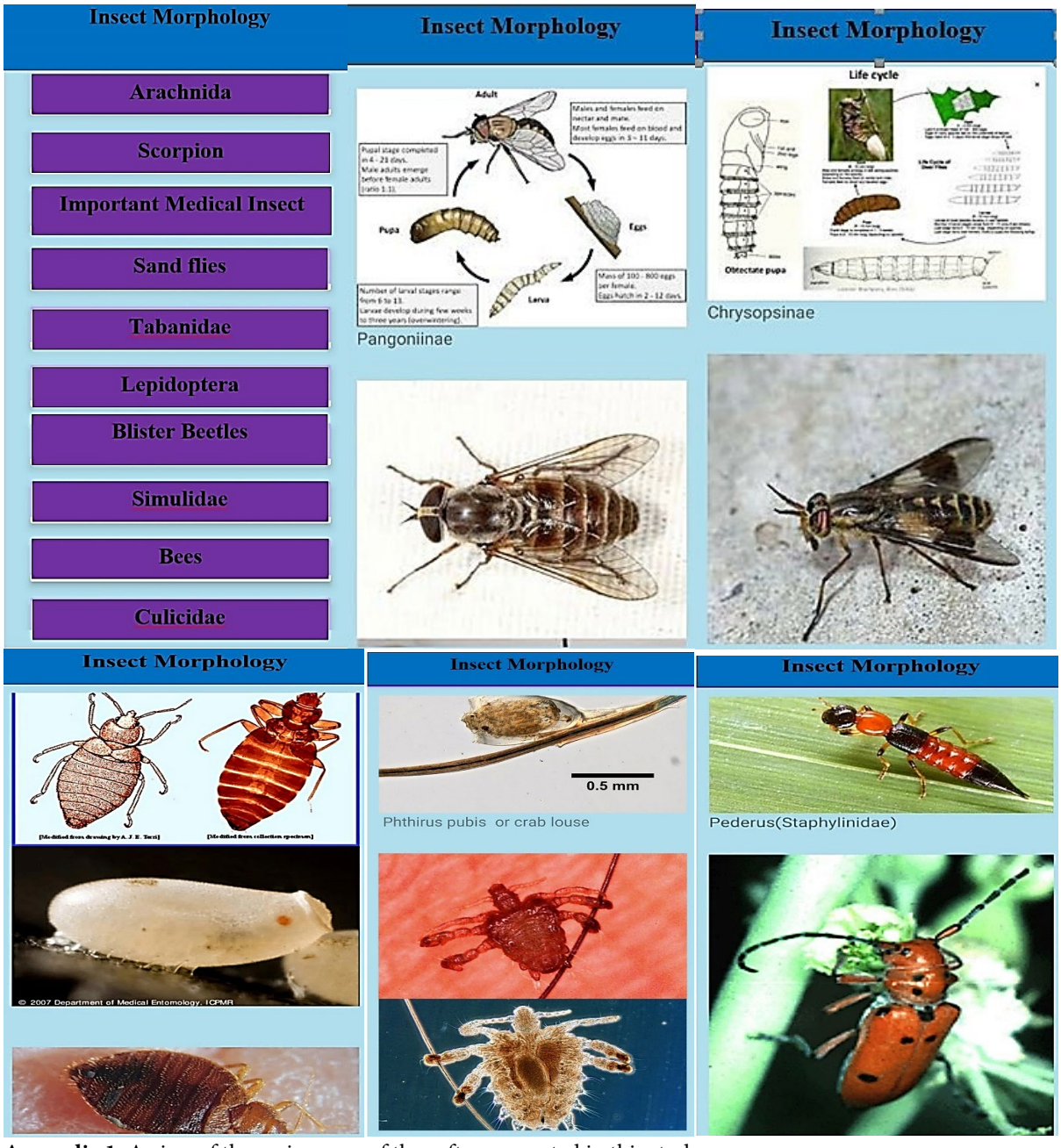
B. Subsections related to insect morphology, such as mouthparts, antennae, and types of legs



C. Subsections related to insect physiology, specifically the respiratory system



D. Subsections related to each group of medically important arthropods presented in the software, including Tabanidae, lice, blister beetles, and bed bugs



Appendix 1. A view of the main pages of the software created in this study