Journal of Education and Learning (EduLearn)
Vol. 19, No. 4, November 2025, pp. 2302~2312
ISSN: 2089-9823 DOI: 10.11591/edulearn.v19i4.22258

Development of a web-based interactive infographic module for learning Arabic grammar at a Malaysian university

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Article Info

Article history:

Received May 9, 2024
Revised Aug 21, 2024
Accepted Sep 19, 2024

Keywords:

Arabic grammar
Interactive infographics
Module development
Website
Self-learning

ABSTRACT

Arabic grammar textbooks often contain complex and detailed explanations that can make them challenging for students to master and understand. The utilization of technology can now help resolve this issue through web-based infographic innovations. Infographics are a method of presenting information that is easy and quick to comprehend, which suits the conveyance of complex information for Arabic grammar learning. Accordingly, this study aims to develop a web-based interactive infographic module for Arabic grammar learning. The design and development research (DDR) approach was adopted to design and develop the module, grounded in the Sidek module construction model, infographics design model (IDM), and constructivism theory. The module's development process involved a needs analysis phase, a design and development phase, and a usability evaluation phase. The creation of module components and elements involved the consensus of ten experts through the Fuzzy Delphi technique. The content validity of the developed module was assessed by five experts based on a modified version of Russell's module content validity questionnaire. The study's findings suggest that the developed module has high content validity. In conclusion, this module has the potential to be utilized by students for self-learning Arabic grammar and is also apt for online learning, offering a more engaging and efficient experience.

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1. INTRODUCTION

Arabic grammar or *Nahu Arab*, is the field that discusses the changes occurring at the end of words and involves sentence construction and the rules of flexion that function to determine the markings at the end of words. This field also touches upon various other aspects such as words that refer to numbers, gender, and sentence structures like *taqdim* (precedence), *ta'khir* (delay), and others. Syntax or Arabic grammar is the most central core in learning the Arabic language, which is the key to understanding the *Quran* (the holy book of Islam that conveys Allah's messages to the Prophet), *hadiths* (the sayings and practices of the Prophet Muhammad), and *sharia laws* (a religious legal system that guides Muslims in their behavior, beliefs, and actions) [1]. Knowledge in Islam also cannot be separated from the fundamental knowledge of the Arabic language [2]. According to Selim [3], Muslims feel that grammar is necessary to aid in the preservation of both the language and the religion. The overall weakness in mastering the Arabic language is due to the failure to understand grammar well. Arabic grammar is the key to understanding the disciplines of the Arabic language.

Learning grammar aims to avoid mistakes related to reading and understanding meanings. Mastery of it is also important for enhancing language skills, particularly reading, writing, and speaking skills, in addition to vocabulary acquisition [4]. Grammatical errors can cause the intended meaning to be inaccurate and lead to significant misunderstandings in comprehending Arabic texts, which are usually found in religious books. Language scholars state that learning all languages in the world emphasizes the aspect of grammar.

The variety of concepts and terms in learning Arabic grammar causes difficulty in understanding [5]. The grammatical methods for the Arabic language are unique compared to other languages due to their overly strict and complex nature. This can be seen through detailed and profound discussions about sentence structure and endings, the position of words, theories, and examples that are too alien to the daily lives of students, causing them to find it difficult and boring to learn. Arabic grammar textbooks also contain detailed information presented in long explanations with unfocused content. This contributes to students' lack of interest in continuing to learn from these books. According to Jusoh *et al*. [6], if we look at the presentation of Arabic grammar information, the conveyed information is overly detailed and philosophical. Referring to the textbook Sharh Ibn 'Aqil, for instance, which is the main reference for courses offered at the Universiti Sultan Zainal Abidin, the information presented contains long descriptions without focusing on key points. This situation causes students to quickly become bored and find it difficult to understand the textbook's content. Therefore, the role played by teaching materials is important in understanding and delving into the syllabus.

Despite the inherently complex nature of Arabic grammar methods, mastery over it is not limited. Various teaching methodologies in Arabic grammar pedagogy have been practised by teachers. However, the selection of creative and appropriate approaches needs to be widely practised in line with current technological advancements. This can have an impact on teaching and learning (T&L) activities while achieving the desired objectives. The general implication for learning patterns should shift from traditional methods, which rely solely on textbook content for teaching, toward using technology as supportive material in delivery [7], [8]. Information in textbooks, especially for Arabic language-related courses, is lengthy and mostly too complex, leading to boredom and disinterest among students in learning it. Teachers now also need to engage students in learning because, for some students, learning Arabic can sometimes be boring as they only sit and listen while the teacher explains without 2-way interaction [9].

In line with today's technological age, students are more interested in the use of innovations in content and curriculum. For most textbooks, the content and presentation method are less engaging and stuck with long sentence writing without focusing on key points. They lean more toward information that has writing, graphics, pictorial notes, colourful notes, and additional features such as interactive audio explanations, animations, and the application of technology. Students need interactive support materials that allow them to understand information faster and more easily compared to traditional methods. Moreover, in today's technological era, students are more interested in using tech gadgets such as smartphones, laptops, and tablets to access information content. The utilization of technology in the learning curriculum has become a necessity in higher education institutions in this sophisticated age. Learning in higher education institutions needs to integrate technology in the delivery of materials. In line with technological advancements, many innovative and engaging learning resources can be utilized [10].

One of the utilizations of technology for conveying information is through the use of infographics. Infographics function to summarize complex and detailed information so that it can be easily understood through visual effects in information delivery [11]. It has become popular and widely used across various sectors worldwide due to its features of flexibility, clarity, aesthetics, and text harmony, which optimize the delivery of information [12], [13]. Information presented through infographics can provide a better understanding to the reader compared to the usual methods of information delivery. The narration of learning content also becomes easier and more effective [14]. According to Tsai *et al*. [15], infographics are often used for complex and voluminous information that needs to be explained precisely. Therefore, graphics or images are used to replace text explanations alone.

The advantages of infographics can be effectively leveraged within the educational sector, particularly in the delivery of complex syllabus content such as Arabic grammar. According to Parveen and Husain [16], infographics help students learn complex subjects, such as language learning. Additionally, through infographics, students can clearly and effectively share their ideas and opinions [17]. Furthermore, using infographics can increase students' scientific knowledge and academic performance [18]. This study aims to apply interactive web-based infographics as a medium for delivering information in Arabic grammar learning. Interactive infographics are a combination of traditional infographics and image content software, where the information accessed depends on parameters selected or set by the user [19], [20]. This interactive infographic module is developed with a focus on the curriculum for bachelor of Arabic language studies students at Universiti Sultan Zainal Abidin for the course on Ibn 'Aqil syntax text studies. This module comprises topic content that is consistent with the course syllabus and includes interactive exercise activities. The objective of the produced module is to maximize the use of technology that students can employ. Research conducted by Wu and Kuwajima [21] suggests that the utilization of infographic information provides additional benefits to

the existing content in textbooks. Through this innovation, textbook content becomes clearer and more memorable. Students can independently access this module and engage in the provided activities repeatedly, thereby enhancing their learning experience and increasing their motivation. To support this, the objective of this study is to develop a web-based interactive infographic module for Arabic grammar learning, ensuring an effective and engaging learning process.

2. MODEL AND THEORY OF MODULE DEVELOPMENT

2.1. Sidek module construction model (2001)

The sidek module construction model (2001) is a comprehensive, systematic approach to module development, ensuring proper preparation and efficient workflows. Introduced for training and academic use, it follows structured stages to produce well-designed modules [22]. This study adapts the steps outlined in the Sidek module construction model (2001) in the module development process to produce modules according to the correct and systematic procedures. Sidek module construction model (2001) involves two main stages in the module construction process: the draft module preparation stage and the evaluation stage of the developed module. Both stages are detailed in the Figure 1.

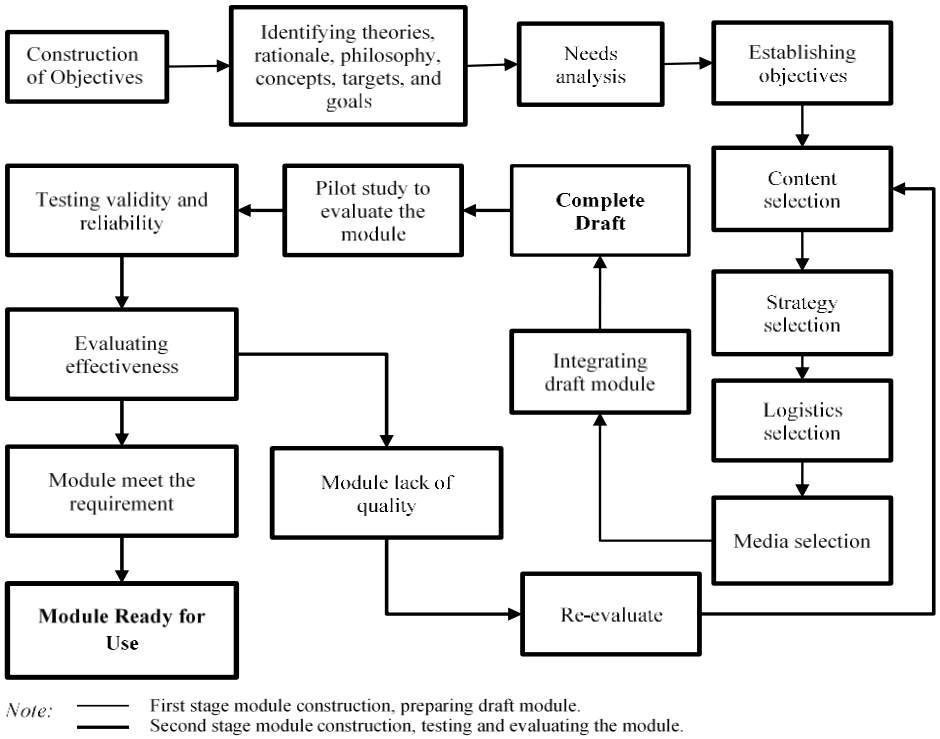

Figure 1. Sidek module development model (2001)

In the context of this study, the steps contained within this model are aligned with the three phases according to the design and development research (DDR) developed by Richey and Klein [23]. The following is the process undertaken in the development of the module, referencing the Sidek module construction model (2001). The preparation of a draft module involves a structured process beginning with the construction of objectives and conducting a needs analysis (phase 1). This is followed by refining and solidifying the objectives to develop a comprehensive draft (phase 2). The next process is to conduct a pilot study to ensure the module is fully prepared for practical application (phase 3).

2.2. Infographic design model (IDM) (2015)

The IDM was established by Kibar and Akkoyunlu [24] and serves as the foundation for the construction of static infographic modules, integrated with the theory of multimedia learning [25] to animate those static infographics. Subsequently, a combination of both types of infographics is presented interactively on a centralized web platform. The IDM comprises three main composite components: content generation,

visual design, and digital design, which are closely related to the knowledge and skills necessary for design. To design effective infographics, information must be thoroughly understood so that the content produced is clear and accurate. Figure 2 shows the components of the IDM.

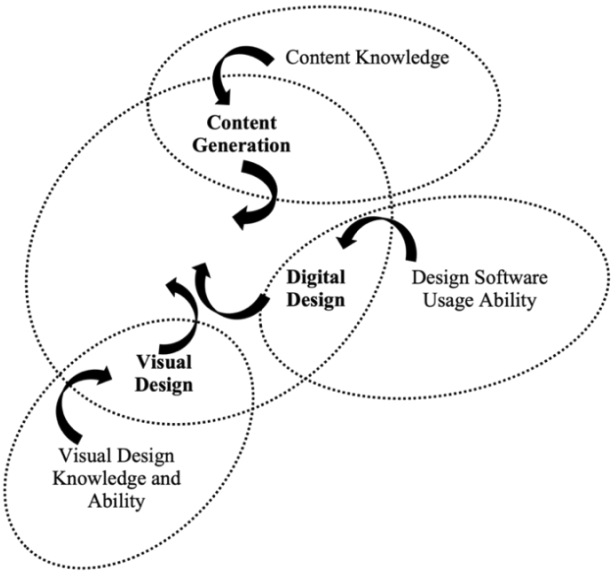

Figure 2. Components of the infographic design model (2015)

The creation of content in infographic design requires skill so that the message intended to be conveyed achieves its objective. Even if the content and visual design have been fully produced, without knowledge and skills in the use of applications for designing, they cannot be translated into visual form. The combination of these three main components in the production of infographics must go through a design process also introduced by Kibar and Akkoyunlu [24], known as the infographic design process.

2.3. Constructivism theory

Constructivism theory is an approach to T&L that explains how humans learn by organising knowledge in their minds [26]. Among the pioneers of constructivism theory are Vygotsky [27], Piaget [28], Dewey [29], and Ausubel [30]. Constructivism believes that learning results from the pre-existing knowledge and experiences of students which influence the knowledge they construct. The constructivist approach aids the T&L process when students are encouraged to construct their concepts by connecting what is learned with the knowledge already present in their minds.

Furthermore, constructivists hold that the learning process is more effective when tools and an environment that actively involve students are provided during the learning sessions. This, in turn, also encourages students to construct knowledge that is more meaningful to themselves. Knowledge is constructed by acknowledging that there is meaning in what is encountered in life and the environment.

Constructivism applies active learning and problem-solving based on individual discovery. The nature of constructivist learning is self-directed learning, problem-solving based on individual discovery, and students are intrinsically motivated. This concept is known as an "independent, self-regulating, and reflective learner" [31], [32]. This constructivist approach is an innovation concerning student-centred T&L styles in the 21st century.

2.4. Application of constructivism theory in multimedia applications

The following are the characteristics of multimedia applications built on constructivism theory [33]: i) focus on the student's experiences and provide an environment that engenders a desire to learn; ii) structured applications for easy acceptance by students; iii) applications that facilitate extrapolation and fill gaps in students' knowledge; iv) application designs feature diverse perspectives and aspects; v) students have the freedom to choose topics of interest, create their questions, and plan their learning; vi) activities are authentic; for example, students use scientific equipment as scientists do in real-life situations; vii) applications give users some degree of control over their learning; viii) students have the opportunity to choose learning strategies that suit their learning style; and ix) applications provide activities that exceed

students' abilities, but with teacher or computer assistance, students can complete them and provide an environment that engenders a desire to learn. These features emphasized by constructivism theory in multimedia learning can be applied in the development of interactive infographic modules to produce a systematic and well-planned module.

3. METHOD

The development study of this module employs the DDR approach introduced by Richey and Klein [23]. This approach involves four phases: i) the needs analysis phase; ii) the design phase; iii) the development phase; and iv) the usability evaluation phase. Although this study's focus is on the development phase, each phase is interconnected. Before building the components and elements for the design phase, the researcher conducts a needs analysis to collect data related to the need to develop this module. A total of 205 student respondents participated in the survey. Then, the components and elements of the module are constructed based on a literature review in the form of a survey using the Fuzzy Delphi method. There were ten experts involved to reach a consensus on the outlined components and elements.

Following this, the development phase of the module is conducted, considering the components and elements agreed upon by the fuzzy experts in the design phase. After the module is developed, five experts are given a set of modified Russell's [34] module content validity questionnaires to determine the content level along with web links for evaluation. The questionnaire contains a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). To determine the content validity level of the module, the total score filled in by experts x is divided by the actual total score y and multiplied by one hundred. A module is considered to have high content validity if it achieves 70% and above and is deemed to have reached a high level of achievement [22], [35]. The value is based on the (1):

$$\frac{Total\ expert\ score\ (x)}{Total\ actual\ score\ (y)} \times 100 = Content\ validity\ mastery\ level \quad (1)$$

according to Russell [34], the content validity items of a module have five aspects. They are: i) align with the target population; ii) the implementation methods of the module are appropriate; iii) the time allocated for running the module is sufficient; iv) the module successfully enhances student achievement in the targeted aspects; and v) the module successfully changes student attitudes towards excellence.

4. RESULTS

This section describes the development phase of the module and addresses the following research questions: what is the form of the interactive infographic module in Arabic grammar learning developed based on expert consensus? and what are the experts' views on the content of the produced module? to answer these research questions, the following discussion details the module development process. The findings obtained through expert consensus in the design phase were selected for the development of the interactive infographic module for Arabic grammar learning at Universiti Sultan Zainal Abidin. The elements agreed upon by the experts formed the basis for the development of this module. After the module was fully developed, five expert evaluators were selected for content validity. The validity assessment of the module is crucial to ensure that the developed module undergoes the set process before usability evaluation is carried out with the students.

4.1. Development of the module

The module development was based on components and elements that reached expert consensus. The four main components and elements for each component in the module development agreed upon by the experts are shown in Figure 3. It shows the components and elements agreed upon by the experts according to their priority. There are four basic components in the module content: objectives, content, learning activities, and assessment. All four components and the list of elements they contain are essential in developing this interactive module, supported by the models and theories underlying this study.

The details of the module development process are displayed in the Figure 4. The module focuses on the introductory topics of the Sharh Ibn 'Aqil textbook, involving 20 verses of Alfiyah Ibn Malik. Key content for each topic is summarised and presented in the form of static infographics. Subsequently, animated infographics were developed using Adobe After Effects software in video format. This infographic information was uploaded to the website to produce interactive information through buttons provided to select information menus in a centralised and engaging manner. Figure 5 represents the display of the produced website module. Figure 5 displays the main interface of the website, which contains the main menu and a brief introduction to the produced module.

Figure 6 illustrates the display of the module's contents, which can be interactively selected and organized according to agreed-upon topics. Figure 7 shows the topic for the user with its Arabic *bayt* (line). It also has a few menu buttons that allow the user to start by reading an original electronic textbook, followed by the second button for a static infographic. The animated infographic is located at the third button and learning activities are at the fourth button. The final button allows users to write a discussion about the topic they have learned. It shows the display of each main menu for each topic. This menu contains a display of traditional textbooks, static infographics, animated infographics, learning activities using Wordwall, and interactive discussions through the Padlet application. The module can be accessed via www.arabigraphic.com.

Module objectives	Module content	Learning activities	Module evaluation
• Apply Arabic syntax methods in speech and writing • Explain the correct use of Arabic syntax methods • Elucidate Arabic syntax methods in understanding verses of the Quran, Hadiths, and Arabic reading materials	• Views of Arab scholars on the division of *Kalimah* (word) • Concepts of *al-Ism* (noun), *al-Fi'l* (verb), and *al-Harf* (letter) • Introduction and concepts of *Al-Mabniyy* (indeclinable) and *al-Mu'rab* (declinable) • Division of types of *al-'I'rab* (the change of the vowel marking on the final letter of the word) • *'I'rab al-Asma' al-Sittah and al-Muthanna* (The grammatical inflection of the six nouns and the dual)	• Interactive virtual discussions like using Padlet • Interactive quizzes such as applications Wordwall, Kahoot • Group activities to create infographic information using Canva • Group activities to create creative videos using TikTok as a medium • Group language games	• Written assignments • Video assignments • Oral tests • Online objective tests

Figure 3. Main components in the module

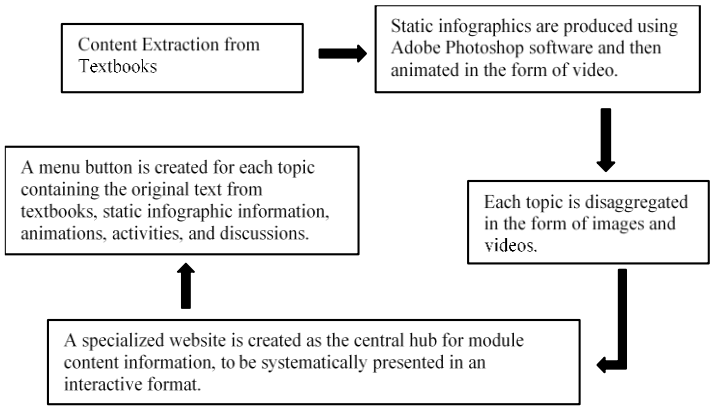

Figure 4. Module development process

Figure 5. Home page interface

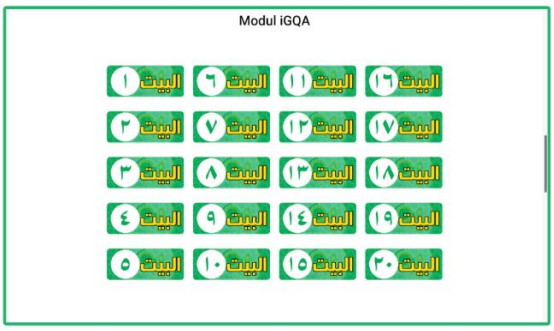

Figure 6. Display of topic menu

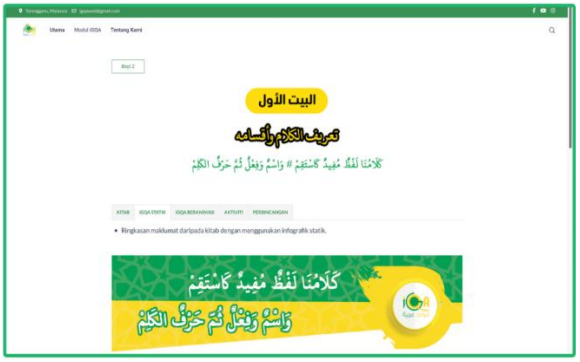

Figure 7. Display of topic contents and menu buttons

4.2. Validity analysis of the module

The study findings on the validity of the module conducted by an expert panel were analysed based on Russell's [34] content validity questionnaire, which was modified to determine the content level of the module shown in Table 1. The Table 1 shows that the minimum percentage value is 92% for the statement that the module's content is appropriate for the allocated time. The maximum percentage is 100% for the statements that the module's content meets its target population and that the content can be implemented perfectly. This is followed by statements that the module's content can improve student performance achievement and can change student attitudes towards excellence, with a value of 96%. Overall, the findings indicate that the content of the module is accurate and appropriate for the module's target.

Table 1. Content validity values based on expert evaluation

No.	Content validity statements	Percentage (%)	Expert views
1.	The module's content meets its target population	100	Accepted
2.	The module's content can be implemented perfectly	100	Accepted
3.	The module's content is appropriate for the allocated time	92	Accepted
4.	The module's content can improve student performance achievement	96	Accepted
5.	The module's content can change student attitudes towards excellence	96	Accepted

5. DISCUSSION

5.1. Integration of Arabic grammar topics through static and animated infographics

This module encompasses topics on Arabic grammar, presented in the form of both static and animated infographic information which is then displayed interactively on a website. This integration of infographics constitutes a learner-centred module utilizing a web platform with the presentation of information in an interactive infographic format. These types of infographics are interactively presented, featuring bi-directional interaction elements such as buttons and menus that can be pressed to display information. This 2-way interaction can capture students' attention and focus on the desired information. Ismaeel and Al Mulhim [36] state that interactive infographics typically contain more information and detail, require the use of various engaging digital applications that encourage users to interact more and involve additional functions to make information easier to acquire and process in their memory.

5.2. Module composition and design

The module contains four main components: objectives, content, activities, and assessment. These components are grounded in Sidek's module construction model (2001). According to this model, the module design process involves the determination of objectives, selection of content, choice of learning strategies (activities), and the choice of logistics and media (assessment). On the other hand, the IDM model (2015) focuses on three crucial aspects of infographic design production: i) skill in understanding information well to ensure clarity and precision in the content produced; ii) content creation in infographic design requires skill to ensure that the message conveyed achieves its objectives; and iii) knowledge and skills regarding the use of design applications are vital to produce appealing visuals. Attractive and concise visual information can enhance understanding in learning. It is also easily comprehended and accelerates the learning process [37]. This module contains multimedia elements such as audio, text, and graphics that can capture students' interest. Nurhikmah *et al*. [38] stated that a module containing multimedia elements can enhance learning outcomes.

The integration of Sidek's module construction model (2001) and the IDM model (2015) forms the basis for the design and development of the module. Experts, through the Fuzzy Delphi method, have been selected to evaluate the components and elements listed based on both models.

5.3. Theoretical underpinnings: cognitive and constructivist theories

In addition, the module incorporates elements of the cognitive theory of multimedia learning and the constructivist theory in multimedia applications, which emphasize that module content must be based on students' experiences and relate to what they already know. Information contained within the module should also be structured from concrete to abstract to be readily assimilable by students. Constructivist theory also adds other elements, namely, the module design should have various perspectives and the information conveyed should fill gaps in the students' knowledge. The produced module should also provide activities that exceed students' abilities, but with the aid of teachers or computers, students can complete them, and it should foster an environment that stimulates the desire to learn. The role of the teacher is not to share knowledge directly but to facilitate opportunities and provide motivation for learners to construct their understanding [39]. The use of infographics in this module practices this theory by positively impacting students' knowledge. Infographics affect the relationship between lessons and the generation of diverse ideas, thereby enhancing efficiency in learning [40].

5.4. Expert validation and usability testing

The module has been developed following the components and elements agreed upon by experts. Subsequently, content validity was carried out to assess the suitability of the module for usability testing with students. All statements related to the module content were accepted by experts. The developed module meets the target population, namely, students studying the course on Ibn 'Aqil syntax text studies. The content of the module is based on this specific course syllabus and targets students who are specifically enrolled in this course. The module's content can also be perfectly executed, referring to the integration of components and elements that merge traditional methods with web-based infographic technology. The allocated time is also suitable because the module acts as a summary of what has been learned in class. Students can access the module content at any time. They can access the module content at any time because this module applies online learning. E-learning enables the delivery of educational content to students via the internet or computers from anywhere and at any time. Students can access learning materials at times that are flexible according to their schedules [41].

5.5. Impact on student performance and attitudes

An infographic-based module can enhance student performance through the advantages it offers. The importance of infographic message design and its use as an educational tool arises from its method of enhancing student performance [42], [43]. The combination of static and animated infographic information presented interactively on a website, attracts student interest, thereby improving their efforts to understand learning content and can enhance their performance. According to Ahmad *et al*. [44], infographics combine data visualization to enhance learning. Students' acceptance of the features present in infographics can also help address comprehension issues they encounter during learning sessions. Their attitude can also change towards excellence with enjoyable interactive learning through exercises, discussions, and learning activities. Additionally, students' focus on key content can increase their interest in learning, thereby reducing the likelihood of boredom and preparing students with 21st century skills to facilitate their ability to assimilate information and foster creativity and innovation [45]–[47]. This is because graphics and text presented in a clear, organized, and engaging manner allow students to concentrate on the most important information, thus reducing cognitive load [36].

6. CONCLUSION

Education in the 21st century emphasizes student-centred learning. Lecturers should diversify their teaching methods to make the T&L process more student-centred. They are encouraged to facilitate student understanding not merely by explaining information in textbooks but by attempting to provide more concise and focused materials as teaching aids. Such materials can give students a clearer understanding without full reliance on the lecturer's guidance. Knowledge about learning innovations must also be explored by lecturers to ensure that T&L activities continue to evolve in line with current technological advancements. The production of infographic-based modules, as examined in this study, presents an alternative to engage students' interest in mastering courses that contain complex information, thus easing their comprehension. The design and development of this module also have implications for the stated theories, with the application of elements through objectives, module content, activities, and assessment. Therefore, this study has reinforced the theoretical framework established in this research and has produced an interactive infographic-based Arabic grammar learning module.

ACKNOWLEDGEMENTS

We are grateful to the experts, whose insights and expertise greatly enhanced the quality of this work. Their contributions were instrumental in shaping the research and its outcomes.

FUNDING INFORMATION

No funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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Muassomah	✓	✓			✓		✓			✓		✓		

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

No conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article [and/or its supplementary materials].

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