International Journal of Teacher Education and Professional Development
Volume 7 • Issue 1

A Web-Based Assessment and Evaluation System for Architectural Design Studio Modules

Ahmed Azmy, King Saud University, Saudi Arabia

Aasem Alabdullatief, King Saud University, Saudi Arabia

Abdulrahman Altassan, King Saud University, Saudi Arabia

https://orcid.org/0000-0001-6351-6045

Hala Mokhtar, King Saud University, Saudi Arabia*

https://orcid.org/0000-0001-9588-7393

ABSTRACT

Architectural design studio modules are known to be difficult to teach and/or assess. To acquire design skills, typically, students have several design modules during their program and several projects for each module. However, traditional project assessment and evaluation lacks consistency, objectivity and fairness. Furthermore, monitoring student progress over the different projects and over the different modules and different semesters is very difficult and needs much time and effort. This work presents a web-based system developed to support fair rubrics-based assessment and evaluation of design projects and to provide in-depth analysis of students' results. It also links between the results over the different projects and the different modules and provides feedback about students' skills and weaknesses in a simple form thus allowing progressive learning. The system has been tested and evaluated and the results show its simplicity, reliability and effectiveness.

KEYWORDS

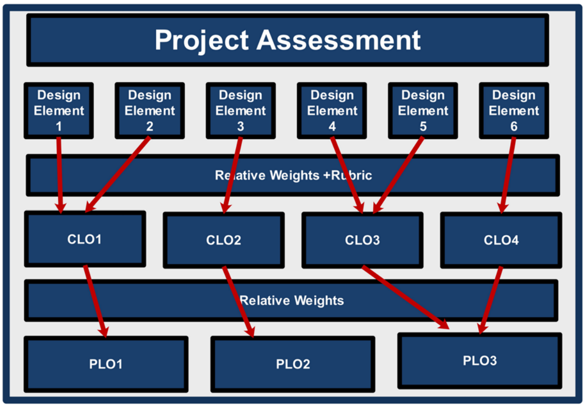
Accreditation, Architecture, Assessment, Design Studio, Progressive Learning, Rubrics, Web-Tool

In the realm of architectural education, the assessment and evaluation of students' work in design studios are crucial components of the learning process. Assessments not only provide feedback to students but also serve as a means to measure their progress and aptitude in various architectural design skills (Subheesh & Sethy, 2020). Traditionally, the evaluation process has relied heavily on subjective judgments, making it challenging to maintain consistency, objectivity, and fairness (Pavlovic, 2021; Ragheb, 2016).

To address this challenge, the integration of rubrics in the assessment and evaluation process has gained considerable attention in recent years. Rubrics provide a structured framework that defines the

DOI: 10.4018/IJTEPD.343044 *Corresponding Author

Figure 1. Mapping the DE Results of Students to Different CLOs, and PLOs



criteria for evaluating student work and the corresponding levels of performance (Stevens & Levi, 2005; Egodawatte, 2010). By employing rubrics, instructors can establish clear expectations, provide constructive feedback, and objectively assess students' design projects.

However, despite the recognized benefits of rubrics, their effective utilization in architectural design studios often faces several obstacles. First and foremost, the creation and implementation of rubrics can be a time-consuming and complex task for instructors. Developing comprehensive rubrics encompassing the multifaceted aspects of architectural design while accommodating diverse student projects poses a significant challenge. Additionally, the manual scoring and interpretation of rubrics can be cumbersome and prone to subjectivity, especially when dealing with many students and projects.

Also, as highlighted by Gipps (2005), learning is not enhanced by feedback in the form of marks or grades alone, but by comments on the good and bad aspects of performance. To provide meaningful feedback, it is important to link the results to the course learning outcomes (CLOs) and the required skills addressed by the course so that students can understand their weaknesses. Moreover, progressive learning requires analysis of results and linking the students' performance over the different modules and the different levels of study. This can be achieved by linking the course learning outcomes to curriculum outcomes – also called student outcomes or program learning outcomes (PLOs) and the required skills of the program. Typically, in architecture, for each project, examiners assess a group of design elements (DEs). Mapping the DE results of students to different CLOs, and the CLOs to PLOs as shown in Figure 1, can provide many insights about students' skills and weaknesses. By analyzing students' results, valuable information can be gathered about the progress of each student. However, collection, aggregation, and analysis of results over the different course outcomes and the different students' outcomes are very difficult and consume much time and effort.

The emergence of technology and its integration into educational practices has opened new avenues for addressing these challenges. By leveraging digital tools and resources, it is now possible to develop and deploy software applications that streamline the use of rubrics in architectural design studio assessments. Such tools can automate the scoring process, provide real-time feedback, and enable instructors to track and monitor students' progress efficiently.

The world wide web (WWW) has gained popularity within educational settings. It has become an inexpensive and easily accessible way to communicate, distribute information, teach courses, and conduct research (Lan, 2001; Barbara, 2011). It can be used to support teaching and evaluation of students' performance, thus improving the learning process. This research aims to present a comprehensive system that facilitates the use of rubrics in the assessment and evaluation of students' work in architectural design studios.

This paper describes a web-based system for architecture design modules. The system aims to support the evaluation and assessment of the design modules and design projects that represent one of the major topics and the major skills required for architectural students. The system is based upon the framework described in Azmy & Mokhtar (2017). This web-based system will provide a user-friendly interface for instructors to create, customize, and deploy rubrics tailored to specific design projects and learning outcomes. Furthermore, it will offer automated scoring capabilities, reducing the time and effort required for assessment while maintaining consistency and objectivity. The system will also gather, aggregate, and analyze students' results to provide useful insights about students' performance and the teaching process. This will help to monitor and improve the learning process and to support the accreditation process by providing the data it requires.

To achieve this, the research adopts a multidisciplinary approach, combining principles from educational technology, human-computer interaction, and architectural pedagogy. By integrating the expertise and insights from these diverse fields, the resulting system was designed to meet the unique requirements and challenges of architectural design studio assessments.

LITERATURE REVIEW

The assessment and evaluation of students' work in architectural design studios are critical aspects of architectural education. Evaluations play a vital role in providing feedback, measuring progress, and shaping students' development as future architects. However, the traditional subjective evaluation methods have often led to inconsistent assessments and subjective judgments, calling for more objective and structured approaches. In recent years, the integration of rubrics in the assessment process has gained prominence as a means to address these challenges.

This literature review aims to examine the existing research and literature on the use of rubrics in architectural education and highlight the potential benefits and limitations of incorporating digital tools to facilitate their implementation.

Project Evaluation Challenges in Architectural Education

In design education, evaluation is crucial for the knowledge transmitter as well as the information receiver. Students must be aware of their learning levels, strengths, weaknesses, areas for progress, knowledge gaps that call for further work, and abilities that require additional honing (Hickman, 2007). Additionally, educators must assess the success of their instructional methods and the level of student learning (Rayment, 2007).

It has been argued that including students in the shared evaluation experience will strengthen the operative knowledge transition of assessment criteria into high-quality outputs (Thomson, 2007). Student participation in the assessment and evaluation procedures is essential for enhancing students' learning abilities. Additionally, such participation offers an invaluable feedback source to guide the creation and improvement of instructional strategies (Huxham et al., 2017).

One of the most popular conventions for evaluating design projects is the jury format, particularly in the field of architectural design education. It serves as the main channel of communication between critics and students (Murphy et al., 2012). The most known performative level of design education is conducted in this manner simultaneously with assessment (Webster, 2006).

A rubric is a scoring method to evaluate students' works in the design studio. Rubrics provide a standardized evaluation by predetermined criteria, simplifying and increasing transparency in grading. Rubrics give both teachers and students a platform for self-evaluation. They aim to provide an accurate and fair evaluation, promote comprehension, and provide guidance for further learning and instruction. This combination of performance and feedback is referred to as ongoing assessment (El Rafie & El Gammal, 2011).

Rubrics are a valuable tool for educators to communicate their expectations to students. They offer guidance on how students can achieve those expectations, assist students in assessing the quality of their work, and pinpoint the specific criteria instructors use to differentiate between performance levels. Rubrics also serve as beneficial records of quality when evaluating educational institutions for accreditation and ranking improvements. When multiple people are involved in performance evaluation, rubrics help to enhance grading consistency and objectivity by standardizing the assessment process. If there are similarities in the comments provided to students regarding their performance flaws or excellence, this can help reduce the time it takes to grade.

The rubrics assessment method used in design research evaluation consists of two stages. The main goal of the first stage is to elicit vocally articulated qualities. The primary function of the second is the numerical scaling of the first-formulated qualities. Prioritization is a normative ranking strategy that is most often used to give weights for a collection of non-numerical criteria according to their subjective value when evaluating intangible traits (Saaty, 1977).

Jones (1996) mentions several problems related to the jury system. These are partly related to the nature of design projects, such as multiple possibilities of approaching design problems, the possibility of using different scales of projects, different building types and materials, and different presentation techniques. Additional problems are related to the members of the jury, their preparation, and their likes and dislikes.

To solve problems related to Jury system, rubrics can be used to enhance student learning outcomes, improve communication between instructors and students, and foster self-assessment and reflection (El Rafie & El Gammal, 2011). By providing a structured framework for assessment, rubrics guide students toward achieving desired performance levels and promote a deeper understanding of architectural design principles.

The Role of Rubrics in Architectural Education

Rubrics play a crucial role in architectural education by providing a structured framework for evaluating students' works in design studios. They offer a set of criteria and levels of performance that guide the assessment process, ensuring transparency, objectivity, and consistency. Several studies have highlighted the benefits of using rubrics in architectural education (Mir et al., 2023).

Oliver and Hatch (2022) developed rubrics to evaluate students in architecture courses that focus on interaction design, which improved feedback and increased evaluator uniformity. Barmuta (2023) found that the use of rubrics helped increase students' interest in their studies, performance, and motivation. According to Navarrete (2023), the use of rubrics allowed architects to monitor their progress and show improvements in a variety of thesis seminar courses. Furthermore, Nasrudin et al. (2022) emphasized the use of rubrics in evaluating undergraduate research skills – a practice that may be advantageous for students studying architecture. According to Kundu et al. (2023), rubrics work well in the software industry, suggesting that they could be used to evaluate the projects of architecture students.

AvotiŇa and Froloviceva (2022) looked at the use of rubrics in art education and proposed a broader trend in education that includes teaching architecture. Analytical rubrics greatly improve EFL students' writing abilities, as demonstrated by Phuong et al. (2023). This conclusion has implications for evaluating communication in architecture education.

Additionally, Rohati et al. (2022) created analytical rubrics for evaluating mathematical reasoning – a technique that can improve the assessment of logical designs in architecture. Rubrics are beneficial, according to Dang and Le (2023) and Gan et al. (2023). They express favorable perceptions that may have an impact on architectural education, especially in the context of supervised project work.

Lastly, Iriani and Luthfiana (2023) examined the difficulties of using analytical rubrics in peer assessments, and Borela and Roy (2023) contend that rubrics might lessen grading prejudice, which is essential for fair evaluations in architectural studies.

All of these results suggest that the use of rubrics could enhance the learning process; however, there is significant variation in the application and outcomes of rubrics used to assess architecture students. Rubrics are primarily used to enable meaningful, fair, and standards-based assessments.

This is especially true in project-based learning environments, where they enable critical feedback regarding student shortcomings and instructional strategies.

Challenges in Implementing Rubrics in Architectural Design Studios

Implementing rubrics in architectural design studios can present several challenges, including the creation of comprehensive rubrics and the subjective nature of manual scoring. Creating comprehensive rubrics that accurately capture the multifaceted aspects of architectural design can be a complex task. Developing comprehensive rubrics represents a real challenge facing instructors in the process of architectural design assessments. Design projects often involve conceptual thinking, technical skills, creativity, and presentation, among other aspects. Developing comprehensive rubrics that effectively capture and evaluate these diverse dimensions can be time-consuming and demanding for instructors (Friedmeyer, 2021).

The manual scoring and interpretation of rubrics can also introduce subjectivity and inconsistency into the assessment process. Investigating inter-rater reliability in architectural design assessments has found that different evaluators can have varying interpretations and scoring approaches when assessing the same design project using rubrics (Pratitis & Purwono, 2018). This subjectivity in scoring can undermine the credibility and fairness of the assessment process.

These challenges highlight the need for streamlining the rubric creation process and addressing the subjectivity of manual scoring in architectural design studios.

Integration of Digital Tools for Rubric Implementation

The use of technology to support education has been the subject of much research in recent years. Computer-assisted learning and assessment provide a means through which the assessment process can be simplified, and associated feedback can be easily conveyed to students (Costa et al., 2010). The World Wide Web has gained popularity and increased use as it is an inexpensive and easily accessible way to communicate, distribute information, teach courses, and carry out assessment activities (Lan, 2001). It is increasingly used as both a learning tool and for delivering online learning programs. Various research efforts focus on the development of web-based learning environments to support individual and collaborative learning. Costa et al. (2010) presented a web-based formative assessment tool for master's students that offers opportunities to students to evaluate their level of understanding of the different topics; it also provides opportunities to instructors to administer the assessment process to integrate and visualize results and give meaningful feedback to students.

The integration of digital tools in the implementation of rubrics offers several advantages, including streamlining rubric creation and automating the scoring process. Digital tools provide a more efficient and flexible approach to rubric creation. Contero et al. (2017) explored the use of a web-based platform in creating and customizing rubrics in computer-aided design. The platform offers user-friendly interfaces that allow users to develop rubrics tailored to specific learning outcomes and project requirements. The researchers highlighted the benefits of digital tools in facilitating collaboration among instructors in the creation and refinement of rubrics. The flexibility of digital platforms enables instructors to modify rubrics as needed, ensuring their alignment with evolving pedagogical goals.

It is expected that artificial intelligence (AI) will enable digital tools to automate the scoring capabilities in architectural design assessments, reducing subjectivity and enhancing consistency. These tools would utilize algorithms and predefined criteria to assess student work, providing instant feedback to both instructors and students. By automating the scoring process, digital tools mitigate the potential biases and inconsistencies associated with manual scoring.

Criticisms of Using Rubrics in the Assessment Process

Rubrics offer several benefits for assessing architecture students, including transparency, alignment with learning goals, and encouragement of self-directed learning. However, they also have drawbacks, such as a lack of attention to detail and uneven effects on improving learning. To bridge these gaps, more research is necessary, especially regarding the comprehensive use of assessment systems in architectural education.

Rubrics may limit the scope of assessment by focusing on predefined criteria, which can overlook the individuality and uniqueness of design projects and the creative thinking and exploration that can occur in architectural design studios. Subjectivity and interpretation can lead to inconsistency and bias in the assessment process, while the reduction of design to quantitative metrics may not fully capture the nuanced qualities of design. Limited flexibility and adaptability may not be able to adapt to changing pedagogical goals, project requirements, or emerging trends in architectural education, and the potential for an overemphasis on outcomes may overlook the design process itself. Design education should emphasize the iterative nature of design thinking, problem-solving skills, and the ability to engage in critical inquiry.

It is important to acknowledge these criticisms and address them in the development of a tool to facilitate the use of rubrics. By incorporating flexibility, encouraging critical thinking, and allowing for subjective judgment within the rubric-based assessment process, these concerns can be mitigated to some extent.

Research Gaps

While research on the use of rubrics in architectural education exists, there are several research gaps and avenues for future exploration, particularly in the development and implementation of digital tools to facilitate rubric utilization in architectural design studios.

One research gap is that previous studies concentrated on using assessment frameworks in a single course, ignoring how they integrate with courses that precede and follow. This omission makes it more difficult for educational leaders to evaluate students thoroughly and effectively, identify areas in which students fall short, and take swift action to correct instructional flaws. One effective way to assess student achievement and alignment with learning objectives is to develop an automated assessment system that spans all course levels and is coupled with a learning outcome matrix. Additionally, this system would make it easier to evaluate and analyze institutional excellence consistently.

Another research gap pertains to the specific features and functionalities that would enhance the effectiveness and usability of digital tools for rubric implementation in architectural design studios. Although some studies have examined the use of digital tools, further investigation is needed to identify the key attributes that would optimize the integration of technology in the assessment process. For example, the research could explore the incorporation of real-time collaboration features, integration with design software, or the inclusion of multimodal feedback options within digital rubric tools.

Moreover, studies should assess the impact of digital tools on various aspects of the assessment process in architectural education. This includes evaluating their influence on student learning outcomes, instructor workload, and the overall assessment experience. By conducting empirical studies and gathering feedback from both students and instructors, researchers can gain insights into the effectiveness and efficiency of digital tools in enhancing assessment and evaluation practices in architectural design studios.

Furthermore, future research should consider the integration of data analytics and learning analytics in the context of rubric-based assessment in architectural design studios. By harnessing the power of data, researchers can gain deeper insights into student performance patterns, identify areas of improvement, and provide personalized feedback. The application of data analytics can also contribute to the continuous refinement and improvement of rubrics, making them more adaptive and aligned with the evolving needs of architectural education.

These research gaps highlight the need for further exploration of digital tools in the context of rubric implementation, the evaluation of their impact on various aspects of the assessment process, and the integration of data analytics for improved assessment practices in architectural design education.

A NEW WEB-BASED ASSESSMENT SYSTEM

In this work, a web-based system that facilitates the use of rubrics for fair assessment of design modules is developed. The developed system aims to improve the learning and assessment processes for architecture design modules and facilitates the accreditation process of architecture programs. It uses criteria-based evaluation and rubrics to guide and clarify the evaluation criteria to achieve fair and reliable assessment. It also links the program learning outcomes and the course learning outcomes for several projects and several design modules; thus, it allows for efficient progressive learning and students' monitoring over the different levels of study in architecture programs.

The system consists of several components and functionalities to be used by instructors, examiners, course coordinators, and students. It provides several components to manage courses, students, sections, projects, and faculty. It also allows the user to analyze results and view statistics about courses and students for different projects. The main components and functionalities of the proposed system are described in the following sub-sections.

Preparation for Assessment

Before using the system, the evaluation form and the rubrics should be prepared. Design modules usually share several PLOs or skills that the student must acquire, and several design elements that can be assessed in the different design projects.

The evaluation form is a general grading sheet that can be used to evaluate any design module as it contains all the design elements to be assessed. However, each project would assess only a subset of these design elements. This can be achieved by setting a weight for each design element when starting a new project. Design elements that are not assessed by the project would have a zero weight. An example of the different design elements is shown in Figure 2.

The design elements are mapped to the CLOs covered by the module, and the CLOs are mapped to the PLOs. Consequently, assessing the CLOs can be achieved by assessing the design elements. An example of mapping design elements to CLOs and PLOs is shown in Figure 2, and an example of the evaluation form is shown in Figure 3.

After defining the different design elements, rubrics are defined to guide marking and evaluation and to ensure fair assessment. Rubrics are also necessary as a kind of feedback given to students to help them understand their marks and their weaknesses. Rubrics should be defined for each design element. An example is shown in Figure 4.

System Initialization

This step is carried out by the system administrator who should input and update the data for the current semester by creating a new session, registering students in the different design modules and sections and assigning modules and sections to coordinators and instructors. The administrator is also responsible for adding the project evaluation form, the program learning outcomes, and the different design elements (DE). An example of adding a design element with its rubric is shown in Figure 5.

Project Creation

A new project is created by the module coordinator who is responsible for adding a description for the project, the selected design elements covered by the project and their weights, the CLOs, and their weights towards the selected PLOs. Figure 6 shows the mapping between the design elements, the CLOs, and the PLOs, while Table 1 shows an example. A coordinator/instructor should also add the examiners for the different sections of the module.

After creating a project, students can see the project description, the different design elements, the rubrics, and the marking scheme as shown in Figure 7. This helps students to know what they should focus on and how to manage their time and priorities while working on projects.

Figure 2. Mapping Design Elements to CLOs and PLOs

Figure 3. The Evaluation Form

Instructor: **Dr.**

Course Title: **Architectural Design _ 1-8**

Section #:

Student Name		1. Site analysis studies	2. Conceptual idea(s)	3. landscape plan	4. Functional relationships	5. Integration of space, function & circulation	6. Form &Elevations	7. Sections	8. visual representation	9. Model craftsmanship	10. Verbal presentation and dialog	TOTAL
	Relative Weights	5	10	5	20	15	15	10	10	5	5	100
1												
2												
3												
4												
5												
6												
7												
8												

Figure 4. Example of Rubrics' Definition

Design Element		Evidences	Relative weight
Verbal presentation and dialog Effective spoken and written communication of design ideas and the related appropriate use of design language		• Ability to demonstrate his ideas • Clear text or title on the boards • Good use of time	**5%**
F 0 pts	**Unacceptable**	• Presentation is unclear due to Confused narrative, uninformative, or significantly overtime.	
D 6 pts **D+ 6.5 pts**	**Poor**	• The presentation is unfocused and lacks coherence. • The speaker failed to speak to his work. • There was no text or title on the boards.	
C 7 pts **C+ 7.5 pts**	**Satisfactory**	• The presentation is adequate and minimally informative, and possibly not completed within the available time. • There was little text or title on the boards, and/or text/titles were poorly written.	
B 8 pts **B+ 8.5 pts**	**Good**	• The presentation is coherent and makes clear points about the work. • The language is clear and supports the presentation. • Student may not have used the time well, but was generally in command of the presentation. Some text/titles appear on the sheets.	
A 9 pts **A+ 9.5 pts**	**Excellent**	• The presentation is dynamic, smooth and well delivered, with clear points and a logical flow. • The speaker used his time well, and employed effective, expressive, and appropriate language. • The boards included titles and used well-written text to explain the ideas.	

Figure 5. Adding Design Element with its Rubric

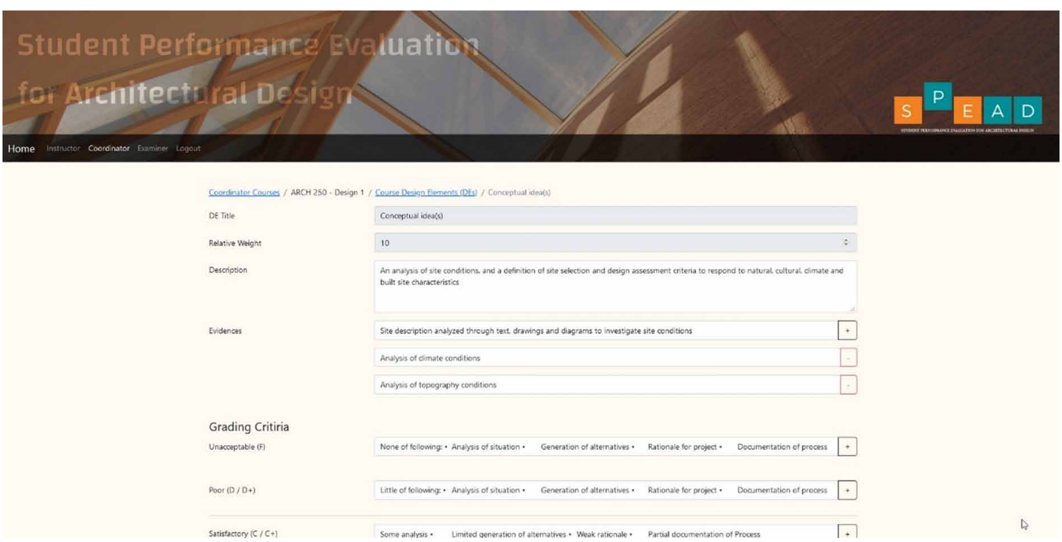


Figure 6. Mapping Between the Design Elements, the CLOs, and the PLOs

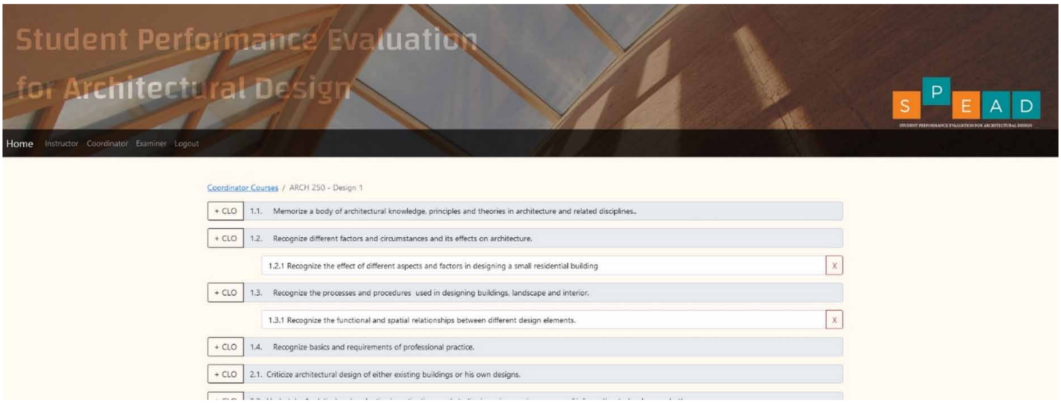
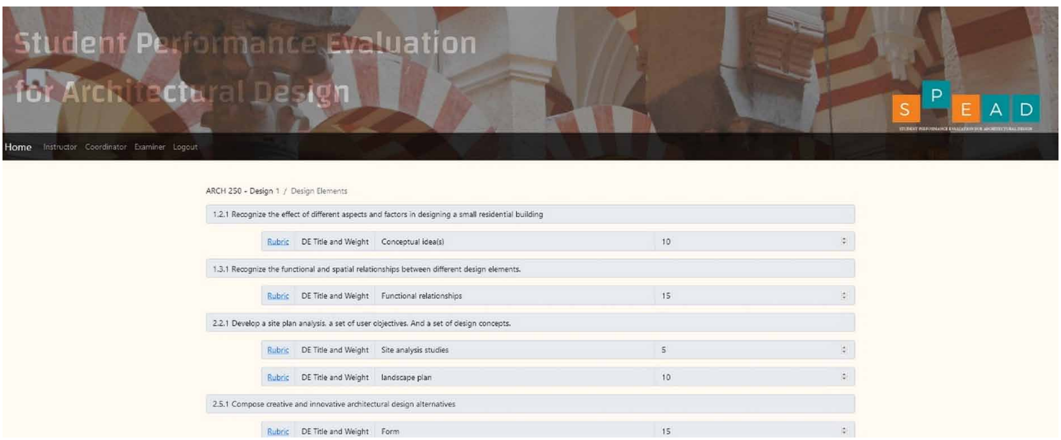


Figure 7. The Different Design Elements, the Rubrics, and the Marking Scheme



Project Assessment

Critique by jury – commonly known as a crit, jury, or design review – is the principal method of feedback and assessment for design modules in architectural education (Parnell et al., 2007). The term "crit" includes formative and summative feedback in small and/or large groups of students and lecturers. Crits present an opportunity for discussion and evaluation of students' works by a group of examiners. The feedback in such crits plays an important role in supporting learning and improving the learning process.

Using the system, after assigning the examiners for each section by the coordinator/ instructors, examiners can log in to the system and add their evaluation online during crits based on the defined rubrics. This is shown in Figure 8.

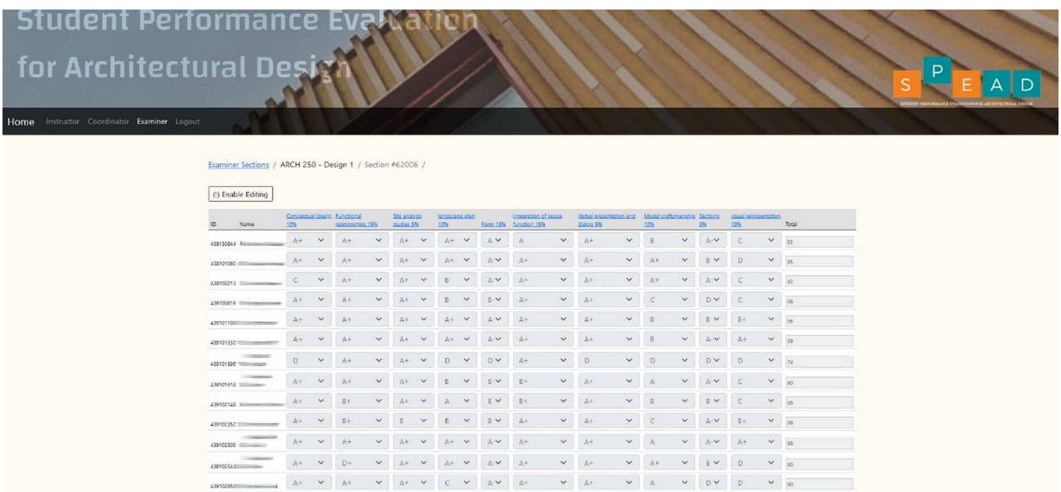
Results and Statistics

After the examination process during which the marks for all students and all sections are added, the system can provide a large number of statistics to analyze the students' performance, the teaching process, the examiners' marking scheme, and the achievement of CLOs and PLOs. Statistics are divided into different categories as follows:

Table 1. Sample Table Showing the Mapping Between the Design Elements, the CLOs, and the PLOs

Program Learning Outcome (PLO)	Course Learning Outcome (CLO)	Design Element (DE)
Compose creative and innovative solutions and design Alternatives for complex problems, and design systems, by integrating technical, environmental, theoretical, and professional knowledge in architecture, to demonstrate imagination capabilities and three-dimensional and spatial thinking.	Compose creative and innovative architectural design and landscape alternatives	1. **Landscape plan:** Ability to respond to site characteristics including zoning, soil, topography, vegetation, and watershed in the development of a project design.
		2. **Functional relationships:** The organization and resolution of the design; by shaping parts into specific relationships to integrate concepts, formal/visual principles, and techniques.
	Demonstrate imagination capabilities, three-dimensional in 3D models, and spatial thinking.	1. **Form & Elevations:** Emphasis on 2d and 3d mapping techniques, patterning, and graphic relationships.
		2. **Integration of space, function & circulation:** Demonstrate fundamental understanding and application of architectural formal + spatial principles as they relate to human experience.

Figure 8. Examiner's Online Evaluation Sheet



On the student level: Statistics include marks of DE and total marks for each student, comparison of DE marks given by different examiners, student CLO achievement, and student PLO achievement. Examples of statistics on the student level are shown in Figure 9.

On the section level: Statistics include the comparison between the design elements marks of the examiners for all students, total average marks for all students, DE average marks for all students, achievements of CLOs per student for the whole section, and achievement of PLOs for the section. Examples of statistics on the section level are shown in Figure 10.

Figure 9. Examples of Statistics on the Student Level

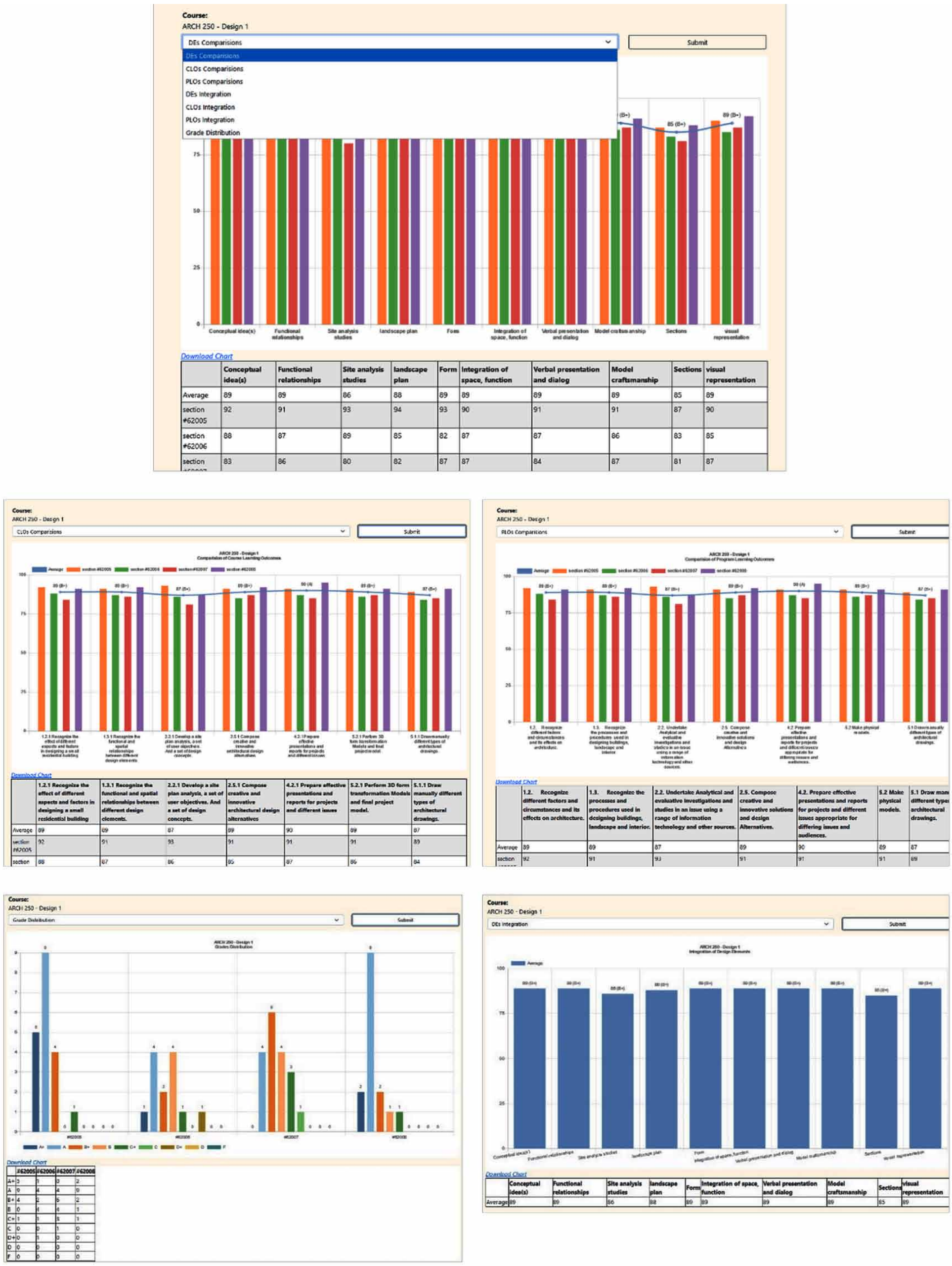
On the module level: Statistics include comparison between DE marks between two or more sections, comparison between CLO achievements between two or more sections, comparison between PLO achievements between two or more sections, comparison between grade distribution between two or more sections, integrated marks and CLO, and PLO achievement for all sections. Examples of statistics on the module level are shown in Figure 11.

Figure 10. Examples of Statistics on the Section Level

Student Report and Student Portfolio

At the end of each semester, the instructor must fill out a student evaluation form for each student as shown in Figure 12, where he can comment on the student's strengths and weaknesses. This evaluation along with the development of the student's skills through the program and over the different modules (based on his marks) are recorded in the system and each student can request

Figure 11. Examples of Statistics on the Module Level



a report detailing this information. To allow progressive learning, the students' marks for the different design elements, and the PLOs' achievement of students over the different modules are aggregated to track the student's skills progress through the program. Instructors also can access students' reports and use this information to support students in a better way. Furthermore, each student has a student portfolio that consists of a student report and a sample of his projects; an example is shown in Figure 13.

Figure 12. Student Evaluation Form

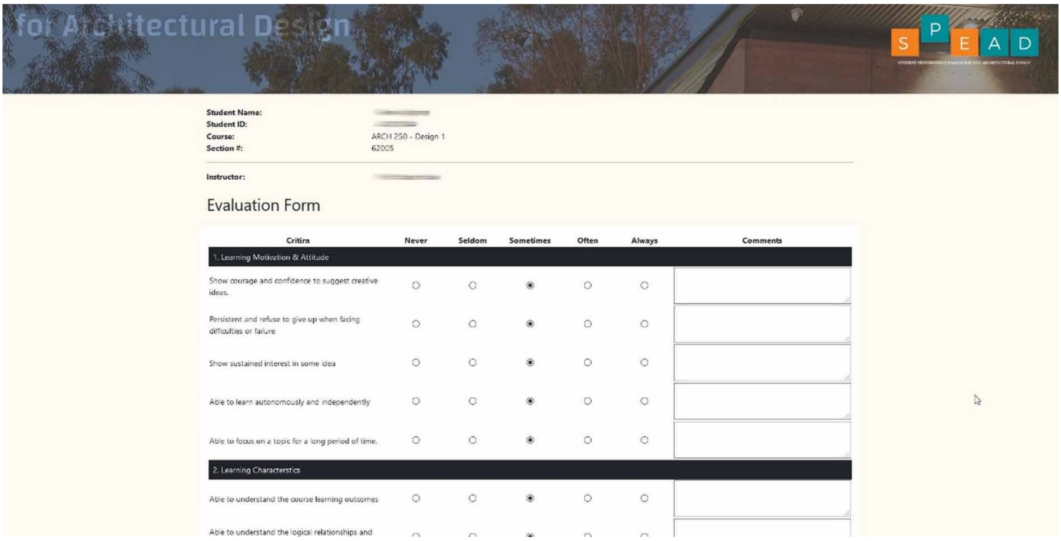


Figure 13. Example of a Student Portfolio

Student name:
(View PLO Portfolio)
Student id:

Course	Site analysis studies	Conceptual idea(s)	landscape plan	Functional relationships	Integration of space, function	Form	Sections	visual representation	Model craftsmanship	Verbal presentation and dialog	Course DEs	Course Stats	Evaluation Form	Student Project
ARCH 250	90.5	91.75	91.75	89.25	90.5	86.75	84.25	89.25	86.75	94.25	Show	View >	View >	--
ARCH 260	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Show	View >	View >	--
ARCH 350	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Show	View >	View >	--
ARCH 360	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Show	View >	View >	--
ARCH 410	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Show	View >	View >	--
ARCH 420	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Show	View >	View >	--
ARCH 430	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Show	View >	View >	--
ARCH 495	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Show	View >	View >	--
DEs Accumelation	90.5	91.75	91.75	89.25	90.5	86.75	84.25	89.25	86.75	94.25	Show	--	--	--
DEs Development	Show	Show	Show	Show	Show	Show	Show	Show	Show	Show	--	--	--	--

EVALUATION

This section provides a detailed evaluation of the developed system. It consists of three main parts. The first part provides a quantitative evaluation and shows how the system can achieve more fairness by comparing the examiners' marks for a group of students with and without using the system and determining the standard deviation for each case. The second part evaluates the system qualitatively by distributing a questionnaire to the examiners, instructors, and coordinators of design modules.

In the third part, a comprehensive analysis that highlights the key benefits and the limitations of the system is presented.

Quantitative Evaluation

To evaluate the developed system, a pilot study has been implemented in the Department of Architecture and Planning at King Saud University. King Saud is the first institute of higher education in Saudi Arabia, established in 1957, and is located in the city of Riyadh. Currently, it has more than 40,000 male and female students, 7% of whom are international students. The Department of Architecture and Planning has more than 650 students. It offers both undergraduate (BSc in Architecture), MSc, and PhD programs in Architecture. The BSc in Architecture program has seven design modules in addition to the graduation project.

The pilot study took place in the year 2022-2023, second semester, where the design-1 module was assessed using the developed system. The module has eight sections and each section has 14-15 students providing a sample of 118 students and 24 examiners, where each examiner assessed one section of 15 students/projects, and each project was assessed by three different examiners. After the assessment of each section by three examiners, all marks were compared. Four sections were assessed using the developed system with rubrics, while the other four sections were evaluated heuristically without any tool. Heuristic assessment means that the assessment is based on the examiner's background and perception without any guidance; thus, the assessment is based on his point of view, preference, and interest. In this case, no formal feedback was given to students to explain their problems and weaknesses. The final mark for each student was submitted to the section instructor and the coordinator either in hardcopy (heuristic assessment) or collected directly from the developed system.

Figure 14 shows the total marks given by the three examiners for the students in one section using the system; Figure 15 shows the total examiners' marks for a section that was assessed heuristically.

To measure the accuracy of the assessment and the similarity/variations between the three examiners' marks, the standard deviation was calculated using the following equation:

$$\sigma = \sqrt{\frac{\Sigma\left(x_i - \mu\right)^2}{N}}$$

where:

σ = standard deviation
x_i = examiner (i) mark

Figure 14. Total Examiners' Marks for a Section Assessed Using the Developed System

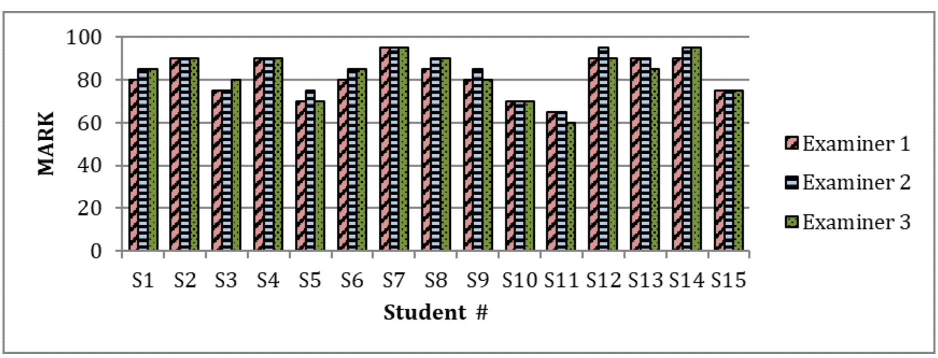
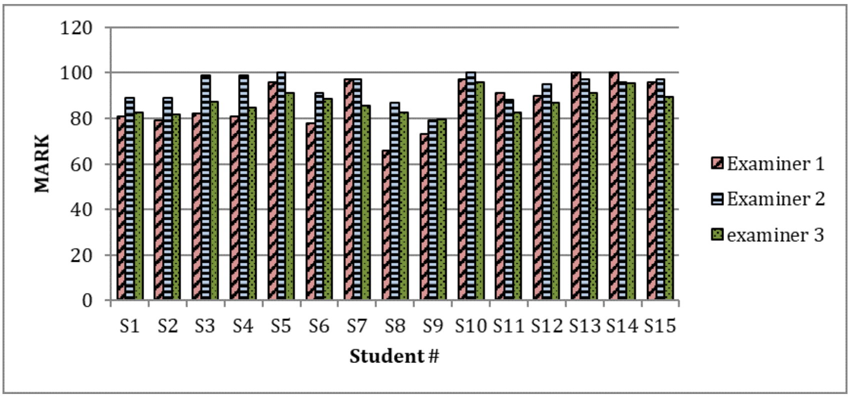


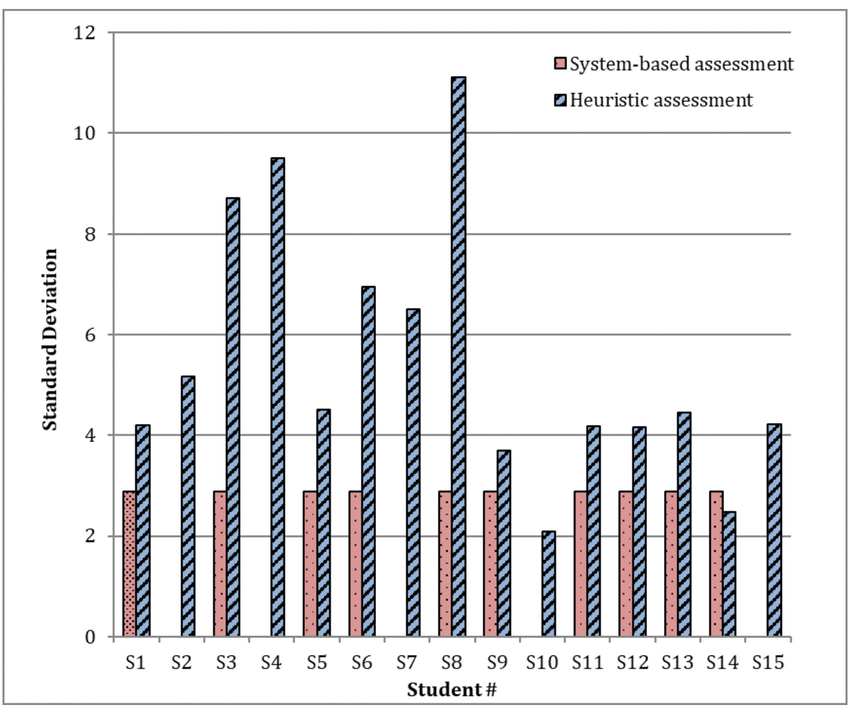
Figure 15. Total Examiners' Marks for a Section Assessed Heuristically



μ = mean value for the three marks
N = #of examiners = 3

The standard deviation among the three examiners for both sections was compared and plotted in Figure 16. As shown in the figure, the system-based assessment has a lower standard deviation than the heuristic assessment, and for some students the standard deviation = 0, which means that the three examiners provided similar marks. This proves that system-based assessment is more accurate and fairer. Similar results were obtained for the other sections where the overall standard deviation was calculated and compared to students' results that were carried out without using the system. The

Figure 16. Standard Deviation Among the Three Examiners for Both Sections



results show that using the system, the difference between examiners' marks was reduced and, in most cases, does not exceed one grade level (e.g. C, C+).

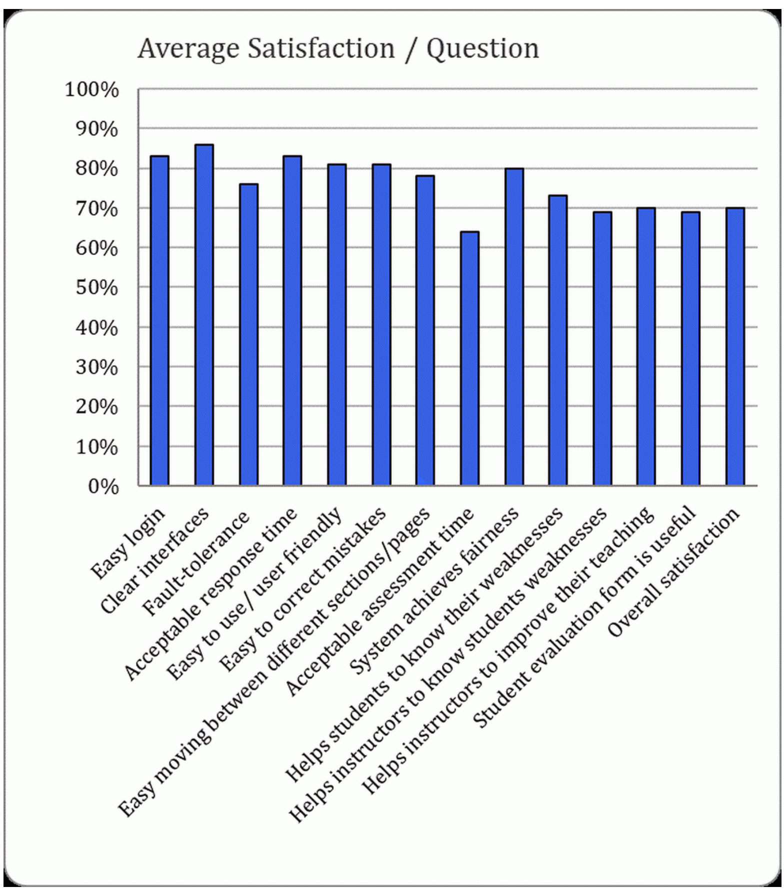
Qualitative Evaluation

To evaluate the developed system, a questionnaire was distributed to the examiners, instructors, and coordinators of design modules at King Saud University. Participants were asked to complete an online survey relating to the web-based system once they had completed the project assessment. Participants were asked 14 5-point Likert-scale questions regarding the user experience, feasibility of the system and general evaluation of the system including easy navigation, clarity, difficulty, appropriateness, usefulness, and ease of use (e.g., "The system was easy to use" – strongly agree (SA – weight 5), agree (A – weight 4), neutral (N – weight 3), disagree (D – weight 2), strongly disagree (SD – weight 1)).

Twenty-nine academic staff took part in the study. For each question, the result represents the weighted average which is computed as the average of the number of votes multiplied by the column weight. Figure 17 shows a summary of the results.

The results show the average level of satisfaction with the system, its functionalities, and its ability to provide a fair assessment. The level of satisfaction mostly lies between 70-80%, which is acceptable and shows the effectiveness of the system. The results suggest that the system is easy to use, feasible, and user-friendly. It also suggests that the system is useful and can be used to improve the fairness and reliability of project evaluation. It also provides a useful tool to track students' progress

Figure 17. Summary of Questionnaire's Results



and weaknesses. However, some examiners indicated that the assessment process is a bit long. Also, many users commented that the student reports need to be represented in a better way.

Significance of Results – Key Benefits and Limitations

The developed system aims at improving the learning and assessment processes for the architecture design modules and facilitates the accreditation of architecture programs by helping the instructors and examiners as follows:

- The system saves time for instructors by simplifying the assessment process and by analyzing the results.
- The system provides data required for accreditation with minimum effort and time.
- It serves as a teaching tool for students to know what they should focus on and how they should manage their time and their priorities while working on projects.
- The system provides a fair assessment process for students by presenting the rubrics to the examiner while he is grading the projects.
- By mapping students' results into course learning outcomes /program learning outcomes, the system facilitates the monitoring of students' progress over different projects and different levels of study, thus improving progressive learning.
- The analysis of results provides valuable feedback about the student's performance and highlights any weaknesses in the teaching process. This can serve as a teaching tool for students to know their own mistakes and their weaknesses. It also provides a guide for instructors to reflect upon their teaching methodologies, thus improving the teaching and learning process.
- The student portfolio can be used as a record of student progress and a certificate of his skills.

To summarize the significance of findings, the system has the potential to improve the efficiency of the assessment process, streamline accreditation processes, enhance student learning, and provide valuable feedback to students. Regarding the system limitations, the student portfolio needs to be improved and students' reports should be represented in a clear, easy-to-understand way. It is also recommended to reduce the rubrics' details and the number of elements to be assessed to encourage examiners to use the system and to reduce the time required for assessment. AI techniques can also be embedded within the system to describe students' characteristics and skills in a better way. This will be considered as future work.

CONCLUSION

This paper describes a web-based system to support the assessment of architectural design modules in a fair and informative way. The system uses criteria-based evaluation and rubrics to achieve fair assessment. It provides several tools to manage courses, students, sections, projects, and faculty. It also supports the assessment of the course learning outcomes and student outcomes to support the accreditation process. The system allows the user to analyze results and view statistics about sections, students, and assessment of examiners for different projects. The system can be considered as a proof of concept for the use of technology to support teaching and assessment. For future work, the system can be generalized to cover other modules and other programs and colleges to improve education.

CONFLICTS OF INTEREST

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

FUNDING STATEMENT

This work was supported by a grant from the "Center for Excellence in Learning and Teaching", King Saud University, KSA.

CORRESPONDING AUTHOR

Correspondence should be addressed to Hala Mokhtar (hmokhtar@ksu.edu.sa)

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Ahmed Azmy is Assistant Professor at College of Architecture and Planning, King Saud University. He received his PhD from Assiut University, Egypt in 2004. His research interests include Architecture design, learning and assessment procedures, e-learning and m-learning.

Aasem Alabdullatief is the chair of the Architecture and Building Sciences Department at the college of Architecture and Planning, King Saud University. He is interested in Sustainability and Architecture in both professional and academia.

Abdulrahman Altassan is an architect and academic, currently serving as a Professor of Architecture at King Saud University. Holding a Ph.D. in Architecture, Dr. Altassan specializes in design methodology and computer-aided architectural design, areas where he has contributed to both theory and practice. In his research, Dr. Altassan delves into critical aspects of architecture such as building codes and legislations, architectural education, and sustainability. His work aims to bridge the gap between innovative architectural practices and regulatory frameworks, ensuring that new developments in the field are both progressive and compliant. Dr. Altassan's commitment to sustainability is reflected in both his academic endeavors and professional projects. He advocates for designs that are not only aesthetically pleasing but also environmentally responsible and socially inclusive. With a career that blends professional practice with academic rigor, Dr. Altassan continues to influence the field of architecture through his research, teaching, and advocacy for sustainable and innovative design practices.

Hala Mokhtar is Associate Professor at College of Computer and Information Sciences, King Saud University, Riyadh, Saudi Arabia. She received her PhD from Liverpool John Moores University, UK in 2003. Her research interests include ubiquitous computing, wireless networks, mobile ad hoc networks, wireless sensor networks, e-learning, assessment and m-learning.