# Automated Usability Evaluation on University Websites using Data Mining Methods *

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التقييم الآلي لسهولة استخدام مواقع الجامعات الالكترونية
باستخدام تقنية تنقيب البيانات

ملخص :

تلعب مواقع الانترنت دورا كبيرا في مختلف المجالات مثل التجارة ، التعليم ، الهندسة والترفيه،ونتيجة لذلك هناك تزايد في تصميم وتطوير مواقع الانترنت لتكون فعالة وسهلة الاستخدام لتسليمها بدرجة عالية من الجودة.

مواقع الجامعات الالكترونية تعتبر بوابة المعلومات والخدمات الالكترونية التي يستخدمها الطلاب والاكاديمين والباحثون ومستخدمين المكتبات والزائرون من المبتدئين والمتمرسين في استخدام المواقع الالكترونية،ونتيجة لذلك يجب أن تلبي حاجات المستخدمين وخدماتهم لكون اغلب الجامعات تبني صفحاتها الالكترونية لخلق الوعي ولترويج جامعتهم من خلال المستخدمين لها.

هناك نسبة قليلة من مواقع الجامعات الالكترونية تصل إلى مستوى جيد في إرضاء حاجة المستخدمين ،وعلى الرغم من أن العديد من المواقع الأكاديمية الالكترونية لا ترضي حاجات مستخدميهم نجد اعتماد المؤسسات التعليمية على المواقع الالكترونية يتزايد لانجاز المهام المختلفة.

لذلك نحتاج إلى تقييم سهولة الاستخدام للمواقع الالكترونية ،إن تقييم سهولة الاستخدام يأتي لتوقع المشاكل والأخطاء التي سوف تواجه مستخدمين الموقع الالكتروني ،واختبار سهولة الاستخدام يوضح لنا التوقعات إذا كانت صحيحة أو خاطئة.

في هذا البحث ،اقترحنا منهجية آلية لتقييم سهولة الاستخدام لمواقع الجامعات الالكترونية باستخدام تقنية تنقيب البيانات،وقد أجرينا تجربتين لتقييم مواقع الجامعات الالكترونية ،التجربة الأولى باستخدام استبيان موجه نحو الطلاب المستخدمين للموقع الالكتروني مثل (استخدام اللون،مساحة العرض،الانتقال لليمين واليسار) والتجربة الثانية باستخدام أدوات آلية تستخدم لتقييم سيناريو لهمه معينة وقياس خصائص للموقع الالكتروني لا يمكن للطلاب قياسها مثل (وقت المهمة،عدد نقرات الفارة،عدد الصفحات).

لقد نفذنا منهجيتنا على جامعة الأزهر – غزه ،وطبقنا منهجيتنا باستخدام أداة الآلة التعليمية واستخراج القواعد عن طريق تقنية تنقيب البيانات لتقييم سهولة الاستخدام على مواقع الجامعات الالكترونية.

وتظهر النتائج بأن المنهجية المستخدمة أنتجت لنا قواعد قوية للتقييم الآلي سهولة الاستخدام على الجامعة.

كلمات مفتاحيه : تنقيب البيانات، التقييم الآلي،سهولة الاستخدام.

*Abstract:*

There are increasing interests in designing and developing effective and usable websites to deliver high degree of quality. A university website is important to its users since it delivers to them information and services such as courses and programs, delivering online learning facilities and online registrations. Despite the fact that many academic websites do not satisfy their users' needs, the institutions' dependence on using these websites for a wide variety of tasks is increasing.

In this paper, we propose an approach to automate usability evaluations of university websites by using data mining method. We conducted two experiments to evaluate University website. We first used a questionnaire directed towards students using the website to examine use of color, display space, scroll left and right, …etc. And then we used automatic tools to measure task scenario of the website attributes which cannot be perceived by students such as task time, number of clicks and number of pages, …etc. We carried out our research on Alazhar University-Gaza.

Our approach is implemented using data mining tool and exploits association rules to evaluate usability on university website. The results show that the proposed approach generated strong rules of automatic evaluation; finally we give some useful recommendations for the university.

**Keywords:** Website Usability, Education Websites, Data Mining, Evaluation, Association Rules.

# 1. Introduction

Nowadays, websites are considered an important tool in many real life applications such as business, education, industry and entertainment. Therefore, there are increasing concerns about the quality of these websites. Developing a website should pass through several design guidelines to ensure that the website can achieve the purposes and goals intended to be accomplished. Unfortunately, website design is often driven by technology, organizational structure or business objectives, rather than by users' needs [1]. It is important to study the effectiveness and efficiency of the website from users' perspective which is called usability. Usability is defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [2]. Therefore, the main objective in this research is to find a way to improve the evaluation of the usability of the educational websites by creating an approach based on data mining methods.

Data Mining (DM) is a discipline which involves the nontrivial discover of implicit, previously unknown, and potentially useful information from data [3]. In this paper, we propose a new approach to replace traditional usability testing by automated usability testing using data mining techniques.

The universities websites are the most important sites visited by thousands of users every day, because they contain many services used by students, teachers and other visitors. Therefore, a university website must be easy to use. Our experiments are conducted on Alazhar University-Gaza.

Our approach has the following main steps. First, we collected data set from testers who are the students of the university. Then, we determined the best metrics of usability testing. The first metrics (users' metrics) asked the students to use the university website to test the usability. The second metrics depended on the technical attributes that the users cannot evaluate such as (time of using website, number of mouse clicks, number of open pages, and number of error pages). Finally, we used association rules from data mining to extract useful knowledge from our data set to automatic usability test of the systems.

The rest of the paper is structured as follows: the second section discusses the related literature, the third section addresses our research methodology, the fourth section describes the experimental results, the fifth section contains a discussion of the results, and the sixth section comprises the conclusion of the paper.

# 2. Related works:

The following is some research done on assessing university websites. These works are applied in different countries and different universities. For example, Mustafa and Al-Zoua'bi in [4] proposed an evaluation study of usability about academic websites of Jordan's universities. They used two evaluation approaches: the evaluation based on questionnaire method and the evaluation based on online automated tools. The results obtained from both approaches showed that the usability of Jordan's university websites were reasonably acceptable, based on the measures of evaluation used. Also, Islam and Tsuji in [5] used two evaluation approaches: the evaluation based on questionnaire method and the evaluation based on online automated tools to evaluate usage of university websites in Bangladesh. The researchers concluded that the universities webmasters should pay more attention to the web design and content to make them more attractive to the user community. Daher and Elkabani in [6] investigated the factors affecting the usability of university web portals in some Lebanese universities. The study is divided into two parts: A qualitative study done on six Lebanese universities by distributing questionnaires to students. The second part is an extended study applied on Beirut Arab University (BAU) web portal. In addition, Abdullah and Wei in [7] focused on website usability issues and evaluation of four Malaysian online news websites. The researchers summarized some of the evaluation methods into: heuristic evaluation, heuristic estimation, cognitive walkthrough, feature inspection, and standards inspection. Hassan in [8] purposed to evaluate the usability of educational websites. In particular, he focused on nine Jordanian university websites. Evaluation criteria for assessing the usability of educational websites were developed; these consisted of five categories: navigation, architecture organization, ease of use and communication, design and content.

# 3. Research Methodology

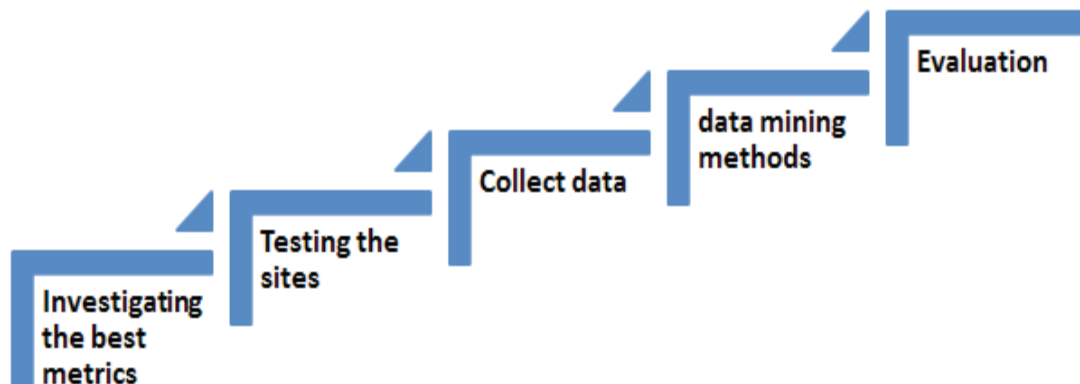As shown in figure 1, we used the following methodology for our research:



**Figure 1:**

**the steps to implement the usability testing approach**

## 3.1 Metrics of usability test

There are many metrics for website usability testing. But in this paper we focused on the metrics needed to evaluate university websites. Using metrics proposed by [4][5][9][10] and [6], we proposed six categories for identifying the metrics: Evaluating content, organization and readability, evaluating navigation and links, evaluating user interface design, evaluating performance and effectiveness, evaluating education purpose and evaluating services in the site. These categories are normally used to evaluate university websites to ensure receiving accurate data from students. To cover these metrics, we proposed 55 questions in our questionnaire.

In addition to these general metrics, we used other metrics to measure the performance of the website which are: task time, confirm of scenario task, total tasks time, task satisfaction, number of clicks, number of pages, and number of page errors for which we used tools to capture.

## 3.2 Data Acquisition

We used two different techniques to collect the data: Questionnaire to collect the answers from students. The questionnaire was inserted in the portal of students, with 55 different questions organized into 6 categories.

Beside the questionnaire we used tools for Scenario Tasks. These tools are used to measure and evaluate some metrics that cannot be measured by

the users (students). We used TestRockit as a tool made for usability benchmark studies. The tool collects data such as task time, confirm (scenario task), total tasks time and task satisfaction. Also, Screen Recorder Pro has been used to collect data such as number of clicks, number of pages, number of error pages. The advantages of these tools are their objective measurements which are total tasks time needed for the evaluation process for the university sites, to ensure the accuracy and comprehensiveness of the process of assessing the ease of usability of university websites. We conducted five different scenario tasks to evaluate a set of metrics about usability of the university websites. Table 1 gives the scenario tasks we used in our evaluations.

**Table 1:**

**the scenario tasks for evaluations of Alazhar University-Gaza website**

| Scenario Task | Task No |
|---|---|
| By using the faculty website, print the banking document for the second semester of 2012/2013 | Task1 |
| By using University›s website, list the staff of Education faculty - Department of Education | Task2 |
| By using the University›s website , search at the university library for a book about the Palestinian issue | Task 3 |
| By using the University›s website, download the study plan for your department | Task 4 |
| By using the University›s website, view your faculty staff C.V via personal staff C.V | Task 5 |

## 3.3 Collecting data set (the answers) from testers and from the tools:

To get data that is ready to use in data mining, we collect the data, select the best attributes, and then conduct the research on a set of preprocessing operations on the data sets before conducting the final experiment. We conducted two sets of operations which are: data preprocessing and data integration.

## 1- Collecting data:

We collect our data from Alazhar University-Gaza which has 13 different faculties and 12,000 registered students. To select the sample for collection, we asked statistical academic experts about the number of the best sample to implement the experiment on Alazhar university students; they suggested we need a sample between 300 to 500 students to ensure the results cover the university distributed based on the number of students in each faculty.

In this research we targeted 390 students as a sample for applying the experiment.

For more effective results in the research, we chose the best effective attributes. See table 2.

**Table 2:**

**The best effective attributes in task scenario**

| Name of data set | Attribute name | Description |
|---|---|---|
| Questionnaire | STDNO | The ID number of the student |
| | COL_NAME | The faculty name of the student |
| | STD_LEVEL | The student level of study |
| | STD_SEX | The student gender |
| | STD_CGPA | The Student›s cumulative rate |
| | Q1 ----Q 55 | The questions of the questionnaire. |
| Tools (scenario tasks) | Task_time | the time of the (scenario task), from start the task to end |
| | Confirm | to ensure the task in complete or the student not complete the task |
| | Total_time_tasks/sec | the total time about all five (scenario task) of the student |

| Name of data set | Attribute name | Description |
|---|---|---|
| | No. Clicks | the number of mouse clicks of the (scenario task), from starting the task to end |
| | No.page | The number of site open pages of the (scenario task), from start the task to end. |
| | No. error pages | The number of error open pages of the (scenario task), from start the task to end. |

## 2- Data preprocessing

Data preprocessing is a data mining technique that involves transforming raw data into a comprehendible format. Real-world data is often incomplete, inconsistent, and/or lacking in certain behaviors or trends, and is likely to contain many errors. Data preprocessing is a proven method of resolving such issues [11][12]. We used the following steps in our research: removing missing data: this operation is important to ensure the accurate input data to the experiment, removing missing record operation is removing the records that have bad effects on the data to ensure accurate results from the experiment. In the dataset, we removed some of records with missing values. Removing identical answers: in the questionnaire experiment we have some identical answers for the same student; for example, when the student chooses the same answer for all questions in the web application questionnaire that showed he did not read all the questions. Therefore, we removed this record from the dataset.

## 3- Data integration:

In order to increase effective data about the case study in the research (Alazhar University-Gaza), we integrated some attributes from university registration system.

After conducting the experiments (Questionnaire and Tools) on the university students, we chose the best effective attributes from register programs as in table 3.

**Table 3:**

**The attributes from registration system**

| No. | Attribute name | Description |
|---|---|---|
| 1 | COL_NAME | The college name of the student |
| 2 | STD_LEVEL | The student level of study |
| 3 | STD_SEX | The student gender |
| 4 | STD_CGPA | The Student›s cumulative rate |

The same attribute in the different data sets may have different names. So, for efficient later integration, simplified data description and understanding of data mining results, we unified these attributes to a unified attribute name in the datasets.

## 3.4 Data mining method

In the research, we chose association rules method because it is a popular and well researched method for discovering interesting relations between variables in large databases. That means we can extract useful relations about our experiment in the research. For example, we can extract relations between the level of students and using interface websites in the questionnaire experiment. Also, we can find relations between the number of mouse clicks and the number of open page in the task scenario experiment [5][13][14].

Many algorithms for generating association rules were presented over time. Some well-known algorithms are Apriori, Eclat and FP-Growth. But they only do half the job, since they are algorithms for mining frequent item sets. Another step needed to be done to generate rules from frequent item sets found in a database.

In our work, we used FP-Growth method for its efficiency. In the first section, the algorithm counts occurrence of items (attribute-value pairs) in the dataset, and stores them to 'header table'. In the second pass, it builds the FP-tree structure by inserting instances. Items in each instance have to be sorted by descending order of their frequency in the dataset, so that the tree can be processed quickly. Items in each instance that do not meet minimum coverage threshold are discarded. If many instances share most frequent items, FP-tree provided high compression close to tree root [15].

## 3.5 Evaluation

Two important measures to evaluate the metrics for association rules are "support" (s) and "confidence" (α), can be defined as follows: Support of a rule is a measure of how frequently the items involved in it occur together. Confidence is the percentage of the number of transactions that contain X∪Y to the total number of records that contain X.

## 4. Results and Discussions

We have two different experimental processes:

the questionnaire experiment and the tools experiment, as follows:

## 4.1 Questionnaire experiment

In this section we present the results about the questionnaire experiment in Alazhar University-Gaza which include strengths and weaknesses of the university websites based on our approach of Automatic Usability Evaluation on University Websites using Data Mining Methods with minimum support = 0.15 and minimum confident = 0.1. Table 4 gives some form of the resultant rules.

**Table 4:**
**Example of questionnaire experiment results**

| | |
|---|---|
| Rule1 | [STD_CGPA = Good] --> [Q6 = A, Q42 = A, Q44 = A, Q43 = A, Q9 = A] |
| Rule2 | [COL_NAME = Elmi] --> [Q42 = A, Q5 = A, Q6 = A,Q12=A, Q43 = A] |
| Rule 3 | [COL_NAME = Adapi] --> [Q6 = A, Q42 = A, Q43 = A, Q44 = A] |
| Rule 4 | [Q3]=A --> [Q6 = A, Q42 = A, Q43 = A, Q44 = A] |
| Rule 5 | [Q2]=B --> [Q14 = B, Q26 = B,Q27=B] |
| Rule 6 | [Q8]=B --> [Q6 = A, STD_CGPA = Good] |
| Rule 7 | [Q14]=B --> [Q1 = B,Q24=B , Q27=B ] |
| Rule 8 | [Q20] =B--> [Q24=B,Q25 = B,Q26=B , Q29=B ,Q31=B] |

***From the rules we can conclude the following strengths of the website:***

1. Most of the university students said they browse the Alazhar University-Gaza website with easy accessibility , and are satisfied with the design. We found this clear in their answers to questions relating to easy use of the website.

2. The services that the university website provided are :

- The online grades service

- Exam schedules service

- Courses schedules service

- Email for students

- Evaluating teacher service

- Announcements service

- Personal Site for teachers

- Scientific conferences

- Social networks (Facebook, twitter)

3. The fourth level students at the university are dealing with the website more quickly and efficiently.

4. The science faculties students easily read the content of website.

5. The humanities faculties students are always comfortable with Arabic language of website.

***From the rules we can conclude the following weaknesses of the website:***

1. Most university students believe that the website lacks e-learning requirements such as downloading video courses and the materials of courses.

2. Most of the students face problems in dealing with the library's website (searching for books and information on books borrowed).

3. Most students do not know who is responsible for/adminstartor the university website to communicate with him/her to inquire about specific problems.

4. Services that the university website do not provided:

- Online advising service.

- Graduates gate.

- Complaints service.

5. The students with a good GPA sometimes took a lot of time to complete the tasks.

## 4.2 Task scenario experiment:

In this section, we present the results about task scenario experiment in the university that include the strengths and weaknesses of university websites after applying our approach of Automatic Usability Evaluation on University Websites using Data Mining Method. Table 5 gives some form of the resultant rules.

**Table 5:**

**Example of task scenario experiment results**

| | |
|---|---|
| Rule1 | [Level = d] --> [No.page_2 = rang 1, Task4_time = rang 2, No. Clicks_5 = rang 1] |

| | |
|---|---|
| Rule2 | [conirm1=yes] --> [Task1_time = rang 3,Total_time_tasks/sec = RANGE 3] |
| Rule 3 | [Task3_time = rang 1] --> [No.page_3 = rang 1, No. Clicks_3 = rang 1] |
| Rule 4 | [Task5_time = rang 2] --> [No. Clicks_5 = rang 1,No.page_5 = rang 1 ] |
| Rule 5 | [Task1_time = rang 3] --> [No. Clicks_2 = rang 1, No. Clicks_3 = rang 3,confirm 3=yes] |
| Rule 6 | [No.page_2 = rang 1] --> [Task1_time = rang 3, Task2_time = rang 3] |
| Rule 7 | [Total_time_tasks/sec = RANGE 3] --> [No.page_1 = range 3, Task1_time = rang 3] |
| Rule 8 | [Task2_time = rang 3] --> [No.page_2 = rang 1] |

***From the rules we can conclude the following strengths of the website:***

1. Most of the fourth level students at Alazhar University complete the tasks quickly.

2. All university students successfully accomplish the first task (using the University's website to print the banking document for the first semester of 2012/2013).

3. All university students successfully accomplish the fourth task (using the University's website to download the study plan of their course)

4. All students perform tasks related to the student portal successfully.

***From the rules we can conclude the following weaknesses of the website:***

1. The first task (using the university website to print the banking document for the first semester of 2012/2013) took a long time to accomplish because it required opening many pages to access the banking document.

2. Scientific faculties' students find it difficult to search for humanities staff. in addition humanities students find it difficult to search for science staff.

3. There are students who do not know that there is a search service for books through the website of the university.

## 5.0 Discussion

In this study, there is a wide range of metrics that we used to evaluate the usability of university websites, and there were two types of these metrics: questionnaire experiment and task scenario.

However, there are some metrics with high impacts for evaluating the usability of university websites, which had a major role in the evaluation. They are

*A.* Attributes positively evaluated

***The following attributes are positively evaluated:***

- The website contains mostly interesting material.

- The students can easily find what want from the website.

- Reading content of this website is easy.

- Students' navigation can easily be tracked.

- The students are comfortable with the colors used at the website.

- The website can be accessed any time.

- Students can easily access the registration page.

*B.* Attributes negatively evaluated

***The following attributes are negatively evaluated:***

- The website has problems during students' registration process.

- The student does not know who to contact for more information about anything in this website.

- The student cannot download lectures and tutorials through the site.

- The student cannot access the financial record from website .

- There is no online grades service.

- There is no online advising service.

- There is no complaints service.

## 6.0 Conclusion and Future Works

In this paper, we proposed an approach for automatic evaluation for usability websites. The proposed approach is to use usability evaluation on university websites using data mining method.

We applied two different experiments; the first is questionnaire experiment and the second is task scenario experiment. We applied the experiments on Alazhar University-Gaza. Our methodology in this research consists of the several steps: first we investigated the best metrics of usability test for educational websites, second we used the metrics to test the site by set of testers (students) using questionnaire approach, third we used other metrics to test the website using some tools, forth we collected data set (the answers) from testers, and from the tools, fifth we investigated data mining methods to extract useful knowledge from our data set to automatic usability test of the systems, and the final step was metrics evaluation.

In the future, we plan to use other data mining methods to evaluate university websites. We can extend our evaluation of usability of website and other users of the website such as teachers, employees and visitors. Also, we can develop subjective evaluation of the university website by using opinion mining techniques.

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