User Interface Design & Evaluation of Mobile Applications

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Summary

The design functionality put forward by mapping the interactiveness of information. The presentation of such information with the user interface model indicates that the guidelines, concepts, and workflows form the deliverables and milestones for achieving a visualized design, therefore forming the right trend is significant to ensure compliance in terms of changing consideration and applying evaluation in the early stages. It is evidenced that prototype design is guided by improvement specifications, includes modes, and variables that increase improvements. The study presents five user interface testing methods. The testing methods are heuristic evaluation, perspective-based user interface testing, cognitive walkthrough, pluralistic walkthrough, and formal usability inspection. It appears that the five testing methods can be combined and matched to produce reasonable results. At last, the study presents different mobile application designs for student projects besides the evaluation of mobile application designs to consider the user needs and usability.

Key words:

User interface, Prototype design, Testing methods, Mobile applications, design evaluation.

1. Introduction

The cornerstone of Human-Computer Interaction HCI is the empirical evaluation of user interfaces through human participation testing. Unlike related fields such as computer science, user interface UI evaluation requires the participation of a partner to assess the practical benefits of the UI intended users.

However, human experimentation presents many challenges that are not generally considered in teaching practice. In some ways, game development is similar to HCI than other fields of computer science because it focuses on the development and evaluation of interactive systems. Game testing is used not only to find bugs but also to assess the user experience of the game to find out if players are enjoying it. Based on these similarities, it appears that the game development provides an excellent platform to teach UI validation [1]. It is possible to describe the structure of these courses and instruct teachers to consider incorporating consumer testing into their curriculum. The cross-disciplinary nature of the courses makes it easy to apply the instructions to any course in a wide range.

Utilization is a significant element in the design of human-computer interfaces. It mostly focuses on creating systems easier to study and practice. Extensive research has remained done in the field of overall consumption assessment. Various utility methods have been produced and verified. These methods are cast-off to evaluate interfaces to identify problems to progress the usability of interfaces.

User Experience UX is a multidisciplinary research area that covers different parts of the experimental and effective use of an artifact, structure, or facility. UX evaluation helps to identify the key elements that provide high-quality interactive product design and overall positive UX. User experience contains user beliefs, preferences, ideas, feelings, and behaviors when interacting with an artifact, system, or facility. It is independent in nature, largely dependent on the setting of use, and is associated with the benefits derived from the product, system, or service. UX is measured by utility such as resolution and efficiency, user perception such as stimulus, reliability, innovation, and various structures related to human emotional response using a variety of methods. For example, if a user "thinks hard" while doing things, he will have consumer emotions. Similarly, UX can also be understood through a long-term daily diary study, daily reproduction method, the Repertory Grid Technique RGT, and Experiential Sampling Method ESM. Additionally, the user can be monitored in a variety of ways, including cameras, sensors, user interaction trackers, and screen capture devices. Redesigning a mobile application requires precise use and a detailed evaluation of design methods and guidelines. In the case of substitute, eco-friendly transport maintained by mobile claims, the redesign procedure can support and improve the user experience, making the citizen more compliant. Currently, most user interfaces are criticized by technologies that require UI expertise. In heuristic evaluation, UI professionals study the interface in-depth and examine features that are familiar to them from experience and lead to usability issues.

Evaluators collect data on issues that arise in their use. These tests provide excellent opportunities to monitor how well the existing interface supports the user's work environment. Under the right circumstances, these methods can be effective. However, many factors limit their use. Few people have enough UI experience to perform these

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evaluations. The techniques are difficult to apply before the interface exists; As a result, any recommendations fall into the final stages of development, and it is too late to make significant changes. If UI experts are not a fragment of the expansion team, they may not be mindful of the restrictions of Technical Strategy or why some design or implementation decisions were made. There may be technical and organizational gaps between the development team and the UI experts, which may interfere with the communication and correction of issues identified during the evaluation. Also, utility testing is typically costly and time overwhelming [2]. This paper revolves around the following question: What are the methods to evaluate user interface design of mobile application prototypes? The other parts of this paper include the following: Section 2 shows related works. In section 3, presents the methodology of the study, while section 4 outlines the discussion, and in section 5, the concluding remarks are given.

2. Related work

User experience UX has developed an important factor in the design of merchandise and services. Companies that relate UX design actions to product expansion are reaping several benefits, such as increasing customer satisfaction as well as lower development and product support costs [3]. Due to its significance, numerous frameworks and representations have been planned for the UX design and evaluation of interactive schemes. These representations lead to better design and determination of the excellence of collaborating systems, goods, and services. UX is exceedingly independent, energetic, and contextual; it develops during communication with the organization. Diverse issues together to influence, define, model, measure, and validate UX provide a challenging job. Less consideration is compensated for understanding and underlining these influences; these influences make UX more complex, distinct, and ambiguous. It is suggested that the controlling element be included in the UX practice to overcome complexity, diversity, and ambiguity issues.

It is simple to install UI validation tools and should calculate the maximum number of evaluation structures. In calculation, the evaluation method provided should be programmed to offer improved results. Studies mentioned joining several assessment methods to obtain more consistent outcomes. In fact, the assessment process is fixed in the graphical controls. In addition, the main advantage of the collaboration is that it supports the evaluation process from the initial stage UI design of the software development sequence. As mentioned earlier, software designers often overlook this golden stream to the well. The next evaluation process is at the finale of the software development cycle.

The related work targets to deliver a summary of user experience prototyping and related questions: How can UX design profit from prototyping? What kind of prototypes and prototyping utensils are there? At what stage of the UX design process is the model most appreciated? Responding to these inquiries will help trainers to select appropriate prototyping techniques and to design prototyping activities step by step.

The study was divided into three central segments. The first shapes the idea of user experience and user experience plan. The next describes the logic of prototypes and the arrangement of prototypes. The third illustrates the inspiration behind the prototyping method and delivers models of tools that help design UX. The concept of UX is generally acknowledged in the field of HCI, though it does not have a fixed definition [4]. Also, the study specifies the scope of the UX to include the goods, schemes, services, and goods that an individual communicates through the user interface [4]. The "International Organization for Standardization" [5] expresses UX in a comparable way, declaring that 'an individual's insights and reactions as a result of the use and/or overuse of an invention, arrangement or service.

Hassenzahl and Tractinsky [6] offer three corresponding elements to better appreciate the UX. Underlining the non-instrumental beliefs of an interactive creation as aesthetic and hedonic properties, which transcends the inherent human needs beyond the device. In contrast to the previous narrow model in HCI, where the device value of the interactive product is very important, and the user-centered investigation and assessment is responsible focuses on the topic of feeling and impact with the particular emotional knowledge that the product generates. UX's feature is to prevent negative emotions and set the stage for positive emotions. Product use is an experimental perspective that is temporarily and temporarily limited. User experience is the product of experience that has a clear beginning and end, needs, motivation, and mood, and the consumer's inner state [6].

User experience design many of the interactions that contribute to the user experience take place through the User Interface UI [4]. However, the plan of the user experience is added than the UI design. The complication of how the customer experience is shaped generates different potentials for product design. Instead of truly creating a user experience, users can influence the experience. Cooper, Rayman & Cronin [7] consider experimental factors that lead to better user experience.

Human-centered design ISO [5] stated that the usage of the human-centered design method advances the user experience. However, there are numerous user-centric design models, including circumstantial design, equally goal-direct design [6] as well as components [8]. The models conform to ISO [5] outline for human-centered design, which has some key principles including:

• Design is based on a clear understanding of customers, environments, and tasks
• The design is determined by a user-centered evaluation model
• The procedure is repeated
• The design represents the user experience in general

The design group comprises variety of services and viewpoints on customers, goals, responsibilities, and the setting in a usage context. It is important to understand this context when crafting goods, systems, or services. The design contains users as a significant basis of data about the perspective of usage and other user needs. Customers contribute to design or evaluate answers with the aid of other design materials and prototypes. The design of all interventions is usually impossible.

The part and significance of prototypes are being extensively calculated in the HCI region. ISO [5] expresses the design of interactive systems that are based on the core components of the model that can be used for examination, strategy, and assessment, albeit in a limited way. Lim, Stolterman, and Tenenberg [9] refer to a framework for various prototypes. The perception is that prototypes have two basic elements:

1. Filters to explore plan space in support of final design choices
2. Demonstrations of design concepts. The power of the model depends on its flaws. Partial prototype design exposes some of the advantages of the concept, while at the same time acting as a filter. It filters features that the designer is concerned about at a specific stage of the design practice. Utilizing the filtering properties of prototypes allows designers to travel difficult design spaces at a time. Gerber and Carroll [10] identify three major problems that interactive application creators need for useful care for the following:

1. Producing the first type of design
2. Repeat in it
3. Communication.

Overall, the methods used to create prototypes are classified according to their reliability: low-reliability, medium-reliability, and high-reliability tools [10]. Carter and Huntusen [11] offer six classes for different forms of prototyping tools:

- Art materials,
- Graphics editing software,
- HTML software,
- Performance software,
- Programming language
- Prototyping software.

Less reliable tools can be used quickly and easily to create beginner models and promote cooperative outlining. These are also enhanced than high-reliability tools for producing design feedback, as users often misunderstand high fidelity or hi-fi models for the final creation, so they are not in the best mood to give criticism. Low fidelity or low-fi devices cannot model complex interventions [12]. Designers improve low-fi tools with descriptions such as sketches and storyboards [13] to better illustrate interactive behavior. Previous literature has shown that it is very difficult to prototype interactive behavior experience [13], [10]. Design interaction requires repetitive design exploration, with several prototyping tools providing a limited support. Therefore, designers become end-user programmers and they need programming services to sustain design. The objective of relating and applying performance is usually to document a record to developers or other investors, [13]. The approach describes the flow of data, actions, and other resources needed by the most significant designer. It also involves labelling the flow such as wireframes, timelines and video official papers are critical in enhancing the design protocol. The model is strongly tied to the flow experience; together have low prototyping device care [10].

High reliability tools are good for generating a great customer experience by precisely modeling the concluding invention. Higher levels of reuse are possible with hi-fi devices associated to low-fi. On the other hand, most hi-fi devices are time consuming and hard to study [12]. Carter and Hunthausen [11] found that many designers use more than one prototyping tool in a task. Various tools are used to create the model and test the usability. Continue prototyping on a computer-based device to maintain utility testing with a more realistic user interface, usually using pens and paper to create the first designs.

Hassenzahl, Platz, Burmester, and Lehner [14] indicate that Hedonic and ergonomic quality features regulate a software's application, includes statements of expanding perspective on usability. The study argues that instead of making the software usable, a broader perspective of consumption drives the design of the user experience. Because it is useful and interesting, the software system can be considered attractive and as a result, the user can use it. The study argues that the recent advent of systems has given more importance to entertainment and recreation and given less work in the traditional sense, which has led some to focus more strongly on the USA and to suggest a broader sense of consumption. Additionally, the study [14] summarizes the key differences between consumption and the traditional approach to UX. User interface adopts a more comprehensive approach aimed at striking a balance between the acquisition and practical aspects of the product, such as beauty, challenge, stimulus or self-expression and

other work-related components (hedonic), but user interface increases "subjectivity". It clearly wants people to experience and share the products they use. From usability to experimental, it is significant to examine what user interface really is and how it looks at the end.

Table 1: Five user interface testing methods

Method	*Development*	*Usability*	*Skills*	*Cost*	*Users*	*Time- Data Analysis*
Heuristic Evaluation	Requirements to implementation, conceptual design, detailed design, implementation	Learnability, Efficiency, Consistency, Errors, Flexibility	Low	Low	No	Low
Perspective Based U.I. inspection	Generate ideas, find solutions conceptual design, detailed design, implementation	Learnability, Efficiency, Consistency, Errors	Low to medium	Low	No	Low
Cognitive Walk through	Realistic tasks, core features, conceptual design, detailed design, implementation	Learnability	Medium to high	Medium	No	Medium to high
Pluralistic walkthroug h	Early design, purpose and goals, conceptual design, detailed design implementation	Learnability, Efficiency, Consistency, Errors, Flexibility	Medium	Medium to High	Yes	Medium
Formal Usability Inspection	Working products, planning Requirements Conceptual designs, detailed designs Implementation	Learnability, Efficiency, Consistency, Errors, Flexibility	High	High	No	High

3. Research Methodology

The methodology applied in this research is a detailed qualitative method for comparing different interface designs of student projects in one of the bachelor's degree courses in the Department of Information Science, College of Computers and Information Systems using five user interface testing methods. Five testing methods are summarized: heuristic evaluation, perspective-based user interface testing, cognitive walkthrough, pluralistic walkthrough, and formal usability inspection. Heuristic evaluation is possibly the most recognized test method, demanding a team of evaluators to review the product contrary to a set of general principles. Perspective-Based User Interface testing different perspectives on the user interface are based on the principle of finding different problems. In affiliate personality-based testing, colleagues adapt to individual roles and review the product based on different people's needs, background, tasks, and pain points. Cognitive walkthrough focuses on the ease of learning. Most testing methods do not require users. The main exception is the pluralistic walkthrough, in which the product team member invites the user to give feedback while listening, observing, and asking questions. As well as, formal usability inspections focus on activities that are structured with clear processes and monitored by experts. The following table shows some of the various and similar points between the five user interface testing methods [15, Tab. I].

3.1 Heuristic Evaluation

Heuristic assessment is a method by which specialists use the obvious guides to estimate the use of user interfaces in number of guided instructions and to report problems. Assessors use established heuristics for example Nielsen understands that helping design teams increases product usage from the beginning of growth [16].

Heuristic is the fastest and most useful method to make decisions or to solve problems [15]. Professionals use heuristic evaluation to determine the use of designs in UX design. Moreover, specialists review the heuristic checklist to find flaws that design teams ignore [17].

3.2 Perspective Based User Interference Inspection

Perspectives are used at each inspection session to draw the inspector's attention to a specific subset of usage issues. Perspectives should be as contradictory as likely. The mixture of different viewpoints should maximize all utility disputes. Perspective based user interference inspection is used to create ideas and to solve the problems.

Consumption perspectives are high-level conditions of human-computer interaction, associated to the steps in the HCI model. Different viewpoints tell different stages or different aspects of the same stage in the HCI model. When consuming a CPU to perform tasks, the user may experience one or more of the succeeding situations [18].

The information and experience of the user does not tell the user how to use the structure to attain the new usage goal. Expert use. The user knows how to use the system but favors to attain the goal efficiently and simply or wants to attain greater goals.

Error Management: The user has a problem with the result of a previous operation and needs to fix the issue. These three perspectives are defined based on the subsequent two questions:

1. Does the user know whether to attain the objective or not.
2. Whether the user is doing the operation appropriately.

If the answer to question 2 is "no" then the situation has "error management". Else, replying "No" to question 1 will lead to "new use" and answering "yes" will lead to "expert use". Consequently, "new use" and "expert use" only consider user actions that are on the right track. All three of these scenarios form the three dimensions we use on specific utility testing technology. Other perspectives can be used, especially for specific application or user interface situations [18].

3.3 Cognitive Walkthrough

Cognitive walkout is a useful assessment tool in which assessors work through a set of responsibilities and ask specific questions from a user viewpoint.
Cognitive Walkthrough focuses on considering the readability of the system for fresh or rare users. Cognitive walkthrough was initially planned as a method to assess walk-up-use systems such as postal kiosks, Automated Teller Machines ATMs. However, Cognitive Walkthrough has been successfully used by advanced systems such as software and software development tools to recognize the initial implementation of possible users [19].

3.4 Pluralistic Walkthrough

A utility testing technique for generating initial design evaluation by assigning paper-based tasks to a group of users who represent a specific product interface and have involvement from the developers of that interface.
When creators and other associates of the production team speak concerns or questions about the interface, utility practitioners, who act as walkthrough managers, guide users through hard-copy boards and assist group feedback evaluation of those responsibilities [20].

3.5 Formal Usability Inspections

There are limitations to the use test with the formal usability inspections such as the limitation of the interface features. Therefore, it can take a limited time in the workshop, and it can be difficult to determine how the product will be affective in the actual environment for weeks or months [20]. In addition, the number of participants is very small, representing the total populace.

Velmourougan, Dhavachelvan, Baskaran, and Ravikumar [21] advise that a useful engineering life cycle offers a comprehensive tactic to evolving an interface consisting of three stages of periodic testing. The first stage is a repetitive theoretical model assessment designed to gain criticism ahead of developing the program. During this stage, it often uses to the formal utility test. For each iteration, there should be three to ten customers, who should be inspected in the office and given at least instructions to test the learning facility. After coding the sample, the next step is to get an advance response almost its use. The similar evaluation codes applied in the first stage assessments are used in this matter, but in the second stage the sample is completed. The third test phase takes place after the interface is prepared, with the goal of estimating the final creation alongside the consumption targets set at the start of growth. Moreover, website usage testing adopts a user-centric approach where the designer focuses on user needs [22]. It is suggested to start the utility test when creating a paper template and continue with the coded interface. However, most websites will not be tested before application. Checks with customers and experts are usually done through skilled examinations. Professionals can remark on usage issues when customers are able to point out minor issues related to tasks [22]. It's good to include customers from this. Follow the same procedures to test the target audience and software applications.

3.6 User-Centric Design

The role of the user-centric design UCD process is important for site and / or application development, and it is certainly important for the success of the project user experience, although it remains a foreign concept. It is often associated with "use" and is attached to it instead of getting it right as the foundation of the project. User-centric design focuses on the design of end-user care information / tools for the benefit of the most effective and efficient way to increase usability [23].

User-centric design (UCD) is a comprehensive expression used to label design action that affect end users, how to describe a design process. It is a wide attitude and a different approach [24]. The UCD has a range of methods in which consumers can interact, but the main idea is that users interact in one way or another. For instance, certain types of UCD users think about their requirements and include them in the design process at specific times; Usually in requirements collection and utility testing. As well as, UCD approaches in which users communicate with designers during the design process and have a profound impact on design.

The term user-centric design was coined by Donald Norman's research laboratory at the University of California, San Diego UCSD in the 1980s, and has been generally used since the publication of the co-author's book: User-Centric System Design. : New Perspectives on Human-Computer 1986. Norman explained more about the UCD concept. The Psychology of Everyday Things POET [25].

These commendations put the customer at the center of the design. The designers enable the work of the user to ensure that the product can be used as intended, and to make the least energy to understand how to use it. Norman commented that extensive, difficult, and inconceivable guides with goods are not user centric. He proposes having a small brochure with the product so that the user can read quickly and gain knowledge about the world [24].

UCD is designed to create an overall user experience that includes all aspects of the product or service that customers want; and combines the most effective and efficient way to increase usability. It is important to establish and integrate several important process steps during the project planning phase and to monitor and maintain the validity of these steps throughout the project. The following key process steps and related tasks are an integral part of the user-centric design process, and without consistently obtaining, modifying, verifying, or adding user-oriented requirements, the project's chances of success are reduced [23].

4. Discussion

The daily interaction of people with the mobile application to achieve the goal of using the app starts from the user interface such as clicking on the central menu and icons. The goal of the study is to discuss the perception of the interface design of the mobile application for student projects to solve design problems caused by a misunderstanding of the needs of users with different backgrounds [26]. Lack suggested that interface designers simplify product features and requirements to equip the visual user interface with human interaction and digital devices. The determination of this revision is to establish the strategy of processer researchers in innovative user interface designs to meet the needs of the visual interface of the Multigeneration Culture [27].

A study by Biswas and Robinson on the user interface of digital strategies claimed that the user interface was difficult due to the user's cognitive problems [28]. The study found that the physical and other sensory characteristics of the elderly were declining, and that clear observation was crucial in designing a clear user interface for computer systems and devices [28]. The implementation of UI design requires substantial information for a use case that rises beyond an explored geovisualization stream. Additional focus implies that interactions provide multiple instances regarding support framework for allowable use provision. The clear focus, in this case, regards accessibility in terms of information sharing, dissolving traditional boundaries, and guiding the geographical phenomenon to ensure a positive functional framework, but also a representation of mapped enablers. Some proposed user interfaces design including the following [29]:

- Registration interfaces for the trainer: where the required data are recorded and the files attached, and after completion of clicking Submit.
- Registration interface for the trainee: where the required data will be recorded and after completion of clicking Register.
- Login interface: Through this interface, you log in to your account in the application in case there is an existing account.
- Learn interface: in which the learning contents, skills, and experiences are displayed in all their classifications, and each classification chosen carries inside it many names of specialized trainers for this classification.
- Room live interface: in which educational live broadcasts are displayed with its various contents provided by the trainers and participation for follow-up by the trainees.
- Complaints interface: Through this interface, complaints are written by the users of this application, and after completing the writing, click Submit.

The following shows different interfaces design of the mobile applications of student projects and the evaluation of user interface.

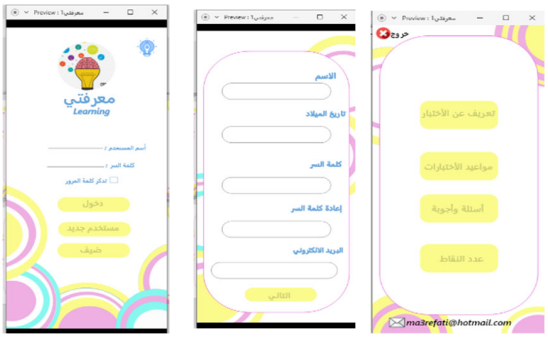

Fig. 1. Design #1 (My Knowledge)

In the given design, sign up login process is defined in a way that a new user can register and then login to the app while previously registered user can directly login into the application. For registration of the new user, the user needs to fill a form that contains personal information, and thus by completing the form user can register to an application and can login into the app accordingly.

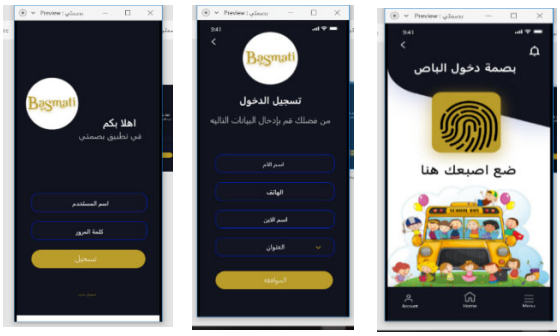

Fig. 2. Design #2 My Fingerprint

In second design of an application there are multiple options available which represent the opening interfaces of an application. There are different icons present like icon which contain application purposes and defining goals of an application. The second interface represents the goals appearance, and login procedure as well as registrations procedures are defined in multiple interfaces. There is another interface which sends a notification to the owner/mother if a child tries to use an application than notification. In addition, the app includes the parents' fingerprint interface.

3. Design #3 Learn KSA

In design three of an app there are multiple screens which displays several type of messages like a screen which displays name of an application for a seconds of time while another screen represents the interface which shows message to trainees for test dates and also there are several other options which are used for transitioning to other screen purposes.

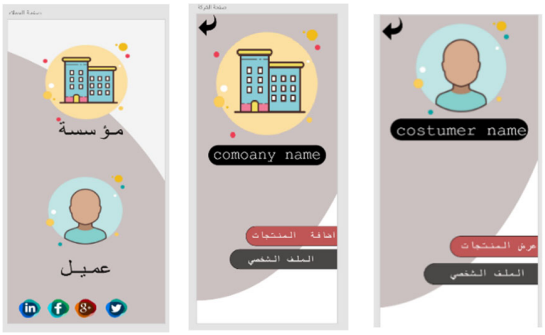

Fig. 4. Design #4 The Instrument

This is the design that contains basic information related to an application. It contains interfaces as login to the application and referrals to social media accounts, There is sign up process for a customer where the customer can create his account and can add new product mention company name, company images and profiles are uploaded accordingly, and product details such as product icons and displaying products in form of list or categories notation.

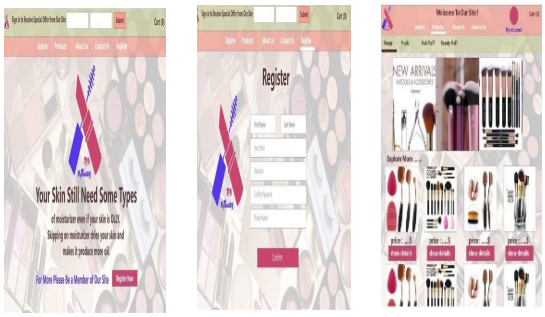

Fig. 5. Design #5 Lipstick and Mascara

There is another interface where users can register by entering the data and login to get a special offer from the app. There are multiple shopping carts options and menu bar options which contain products, discovery, and contact information while other interfaces contain information related to products and accessories, tools, and price options including search options to explore products and new tools and accessories. There is another consulting interface in an app where users communicate with working teams to respond to requests, comments on products and get contact information.

Keeping the interface straightforward, the best interfaces are practically undetectable to the client. They evade pointless components and are unmistakably noticeable on the marks, in the message utilized, and in the language utilized.

Utilizing standard UI parts is to make security. By utilizing basic components in UI, clients feel better and ready to do things quicker. Making designs in language, format, and plan all through the site is additionally essential to encourage effectiveness. When a client sees how to accomplish something, they can move that ability to different pieces of the mobile application.
Moreover, it is important to be intentional in mobile application design. For instance, making a page dependent on the significance of spatial connections between the components on each page. Dealing with objects assists with drawing consideration towards the most significant data in examining and perusing. Also, using shading and surface deliberately by centering or diverting the instrument with shading, light, differentiation, and surface [30].

Ensuring the framework imparts what's going on and advising clients about the area, action, state changes, or mistakes. Also, utilizing distinctive UI segments to impart the status if essential the subsequent stages will lessen the disappointment for the client. Considering the default via cautiously analyzing and acting the objectives that individuals bring to the interface, can make client default. This is particularly significant when planning a structure, where one can pre-select or fill in specific fields.

5. Conclusion

In general, it is expected that there will be several limitations that make it hard to form interfaces to existing policies especially in the prototyping stage with the student projects, so policies concentrate on the growth of user interface without full integration into the application development sequence. Several of the processes analyzed involve different tools to create the final UI, and in few cases incompatible external tools. Best of all, the UI tools provided are combined into a unified development setting that lets the production of a basic application that is integrated into the interface.

The five user interface testing methods that were described and compared in the study; are heuristic evaluation, perspective-based user interface testing, cognitive walkthrough, pluralistic walkthrough, and formal usability inspection. Moreover, answering the research question, the five testing methods would be combined and matched to produce reasonable results. For instance, team members using a heuristic evaluation review products, apps, or services as well as combine between the other different methods.

As for the User-centric design in the study, UCD is an overall term for reasoning and strategy that centers around the plan and incorporation of clients in the plan of modernized frameworks. The processes by which students take an interest can be changed from a project to another based on the evaluation and the usability of the user interface. furthermore, different techniques have been discussed to help with the User-centric design, including utility testing, utility building, heuristic assessment, markdown assessment, and member plan. Snappy assessments that convey thoughts to some delegate clients are additionally significant for criticism toward the start of the plan. After all, including customers' needs in designing appears to prompt the improvement of more valuable and fulfilling plans in user interface design & during the evaluation of mobile applications. It is expected that the use of mobile sites in the future may be more than the use of applications for various reasons, including storage space and the usability of the user

interface [31]. For these reasons, it is essential that students consider different needs and usability of user interfaces when designing prototypes for mobile applications for their projects.

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