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Almansour, F

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Supporting Developers' Decisions in the Use of New Learning Resources System in Achieving Efficient Usable System Design

Fahad Almansour^{1,1}, Liz Stuart¹

¹ School of Computing & Mathematics, Plymouth University, UK
{fahad.almansour, liz.stuart}@plymouth.ac.uk

Abstract. This research centres on Usability Evaluation Methods (UEMSs) with the aim of supporting developers' decisions in the use of learning resources in achieving efficient usable system design. The suggestion is made pertaining to a new usability evaluation model (dEv) with the objective to support decisions to overcome three key obstacles: firstly, the involvement of users in the preliminary stages of the development process; 2) developers' mind set-related issues as a result of either their lack of UEMS or the provision of too many; and 3) the complete lack of understanding surrounding UEMS importance. An experimental approach was applied in addition to a survey-based questionnaire in an effort to examining the issues pertaining to UEMS. Empirical works were carried out with system developers in order to test the dEv, the results of which have been presented from the empirical study to support various considerations, such as: system developers' decisions and their involvement in the earlier phases of the design of systems; the gathering of specifications and end-users' feedback; and enhancing usability evaluation learning capacity.

Keywords: Usability, UEMS learning resource, Evaluation methods, Usable system design, decision making

1 Introduction

Software usability is the main goal of producing products. the International Organization for Standardization (ISO 9241-11) referred to usability as '*the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specific context of use*' [40]. Incredibly, usability has been incorrectly classified as a part of software development attached or added on towards the end of the development cycle; this is often misunderstood as being part of the 'finishing' of the product, which is totally incorrect. Usability is core to the success of the software. Usability is central to efficiency and throughput, and thus it is core to business and software development [22]

Measuring the usability of software is another main concept that should developers and originations concern about it and its considered as a central activity in the usability process [18]. Evaluation is the means by which evaluators assess: (i) the quality of the software, (ii) the usability of the system, (iii) the extent to which the user's requirements have been met, and (iv) the ability to identify system problems. Note that the latter is based on user satisfaction with the system [16, 49]. This stage of the software development lifecycle is crucial for many reasons. Firstly, the communication of requirements between users and developers is a difficult task, despite the numerous methodologies that exist to support this process. Thus, it is essential that checks are carried out so as to ensure the product matches user expectations. It is equally important to ensure that the developer has an in-depth appreciation of how the user intends to use the software, as well as any limitations of the software. Thus, it is a very worthwhile and important stage of the software development lifecycle [39].

Software developers usability and evaluation knowledge's is essential factor that lead them to consider there two concepts during the development process. Thus, learning resources a way to enhance the developer's skills and about how to measure their product and enhance their ability of making decision about the usability level[12]. Furthermore, the aim of creating educational software is to support learning. However creating an appropriate resource for novice user and support their request is challenge[6].

This paper proposes that developer knowledge of both usability and evaluation methods impact the decision making toward to friendly product for the end user that easy to use. Hence, our dEv learning resource and model have built to prompt the developers for using evaluation methods during the development process and increase the software usability [5]. This study we measure the suggested learning resource to investigate two points: (1) the learning resource usability issues. (2) The participates ability for making decision on the dEv learning resource. In this paper we report our findings, the emerging themes of our qualitative research conducted using user testing and thinking aloud, also using questionnaire for quantitative research. The data was collected by user testing, thinking aloud, observation and questionnaire with the developers who have already involved in the learning resource requirements.

The paper is organised as follows. The following section reviews relevant literature, while Section 3 presents the research methodology to evaluate the proposed model. Section 4 describes the finding of the study, followed by Section 5 presents a discussion of the results. Section 6 concludes the study and suggests future work.

2 Literature Review

This section takes the key software usability and usability evaluation method concepts and reviews these in mind of their ability to support the creation of usable software. Predominantly, this review centres on various usability obstacles and how these may be overcome and managed throughout the process of development.

Developers with different level of programming experience are able to create such as product; however creating a usable product is the challenge. Thus, number of design principles and guidelines are established to help developers creating usable software. For example Nielsen coined his own key aspects of usability when he listed the following attributes to identify the usability of a system [37], [49] present their taxonomy and various principles, such as simplicity, structure, consistency and tolerance. A number of design principles referred to as 'Eight Golden Rules', where these 8 principles are considered as guideline for software design [45].

Following common design principles to create a usable product is still encountering number of challenges that prevent developers to ease of use product. User involvement is one challenge that impacts the software usability. Ardito et al. (2014) reported that user involvement on the early stage of the development is positively impact the design, however it's complicated [30]. Furthermore, problem of not involving the user within the development of software has also been identified commercially [7]. Conducting evaluation methods during the development process also consider as challenge

User-centred design (UCD) is a way of improving overall software usability [11, 27]. User-centred design is a well-established software development methodology that incorporates design evaluation within the core development lifecycle [11]. There are different terms used in the field that have the same concept of UCD: for instance User-Centred System Design (UCSD), Usability Engineering [41] and Human-Centred Design (HCD) [33]. The term UCSD originates from research by Norman [50] back in the 1980s. Since then, UCSD has been widely adopted [2, 28]. It focuses on user's requirements and needs during the software development stages [39]. The concept of UCD emphasises the involvement of the user and their activities in order to achieve product goals. Thus, collecting data and information at the early stage of the development process is considered as a key element for supporting decision maker [21]. Bevan (2005) lists a number of benefits behind the UCD main concept and these benefits impacted on the product sales, development cost, easy- of - use and supporting and maintaining costs [9].

The agile development process has been widely integrated with other development processes: for instance, User-Centred Design (UCD). The integration aims at improving the level of software usability by combine the strength points of both approaches and puts them in one model to solve the development challenges. For instance, user involvement is one of the challenges facing developers during the development process; thus, integration is a way of addressing this challenge. Many authors have proposed different integration frameworks for different levels of integration, where each framework has its own goals [19, 25, 34, 36, 43, 44].

Developer preferences may be viewed as one of the predominant obstacles hindering the development of usable software, as in the case of the mind-set of the developer. It has been stated by [7] that there are three key obstacles effecting developers' ability to create usable software and carrying out usability assessments, including development mind-set, the wealth of resources necessary to complete a usability evaluation, and the problems and complexities involving users in the usability evaluation process. Accordingly, various efforts have been made by developers to avoid users' participation in the development stages owing to the view that such involvement can waste time, may mean unrealistic requests, and the

uncertainty of users concerning their needs [7]. Moreover, the lack of usability evaluation knowledge is one of the key issues facing developers in the completion of the usability assessments on products [42]. Accordingly, the creation of software with a lower level of usability evaluation knowledge and without the direct participation of users in the process of development can mean developers create products based on their viewpoints and own experiences. As such, some products following the completion of development.

Developer training proposed as solution to increase the developer awareness of user involvement and evaluation conduction. Thus, Number of previous studies identified that inexperienced usability evaluators are able to conduct the usability evaluation by using tools, training or learning resource to come up with list of identifying problems [13, 24, 47]. Furthermore, in 2012 Skov and Stage conducted a study to investigate the student ability of conducting evaluation after they have training course. This study provided 234 of first-year undergraduate students with 40 hours of training. as results of this experiment students “gained good competence in conducting the evaluation, defining user tasks and producing a usability report, while they were less successful in acquiring skills for identifying and describing usability problems” [46].

3 Research Method

This work applied usability assessment approaches involving end users in evaluating the design and accordingly gathering dEv-related feedback. Accordingly, there has been the use of four common approaches at various stages of the usability evaluation process, namely observations, thinking aloud, questionnaire and user-testing [23]. Table 1 details the various testing methods applied in this work, and the various objectives underpinning their use. User testing enabled participants to carry out tasks on the real dEv product. Such a method was applied as one of the key aspects in usability methods that results in users being able to interact with the real design and deliver critical data whilst also increasing usability issues. Moreover, user testing is a suitable method to establishing the capacity of users to establish usability issues and accordingly propose solutions[38] . Thinking aloud also has been applied in order to encourage participants to communicate what they are doing. Participants’ thoughts throughout the user testing stage aids in the establishing of system errors and the root causes behind issues [23]. Observation was also adopted in order to focus on the interaction of users throughout the user-testing process. This method is useful in establishing the key usability issues and accordingly creating a usable user interaction design [20]. The questionnaire method was implemented in mind of gathering data pertaining to user satisfaction with our dEv resource. Questionnaires are recognised as valuable when striving to gain insight into users’ feelings throughout testing and accordingly measuring their degree of product satisfaction [8]. Moreover, the questionnaire is regarded as a suitable method for gathering quantitative data to compile statistics [23].

Table 1. Research method phases for the dEv usability testing

Phase No	Phase denomination	Purpose and achievement
Phase (1)	User Testing	<ul style="list-style-type: none"> ▪ To assess the (dEv) learning resource. ▪ To increase usability issues ▪ To complete measurement of users' overall capacity to enhance the model ▪ To discuss user finding issues
Phase (2)	Thinking aloud	<ul style="list-style-type: none"> ▪ To understand users thoughts throughout the testing process
Phase (3)	Observation	<ul style="list-style-type: none"> ▪ To observe the interactions of users throughout the testing process ▪ To detail additional usability issues
Phase (4)	Survey based Questionnaire	<ul style="list-style-type: none"> ▪ To establish the degree of user satisfaction with the learning resource ▪ To collect user recommendations and devise solutions

The sample contained 11 participants, all of whom had had some degree of participation in the designing development process of the dEv. The main criteria for the sample selection were as follows: subjects should have programming experience; and the subjects should have a minimum of one designing product and be able to learn more about the user interaction design assessment approaches. This work has carried out in-person sessions, involving individuals sitting with the researcher on a one-to-one basis. Approximately 1 hour was assigned to each participant. The subjects were seen to have some degree of dEv-use experience, albeit differing: 3 subjects described themselves as 'beginners', whilst 7 were 'intermediate' and 1 'expert'. Both SPSS and NVivo analysis software tools were applied in examination of qualitative and quantitative data.

Procedure

Each participant took approximately one hour to complete this study tasks and collect feedback. At the beginning of the session, the researcher introduced the study aims and procedure, and then asked them to sign paperwork. This study asked participants performing two tasks to achieve the study goals. These tasks aimed to preamble participants on the learning resource. There were two test scenarios, including four test cases, which were to be completed and would take approximately 20 minutes. Afterwards, participants were asked to choose any unknown evaluation method form the dEv resource and free testing to explore and learn from it. During the free-testing, some issues were highlighted for discussion with the participants and enabled further collection of feedback and usability problems. Furthermore, thinking-aloud conducted during the free testing part to collect more data about the participant finding issues. At the end of the session, the questionnaire was filled in in an effort to measure user satisfaction with the resource.

4 Research Findings

This section's aim is to provide an overview of the evidence garnered from the key findings of the literature, as well as from the empirical works supporting the decisions made by system developers and their overall involvement in the earlier stages of system design; improving usability assessment learning capacity and the garnering of end-user feedback and user requirements.

4.1 System developers' decisions and their involvement in the early phase of the design system

Usability themes

An overall this study comes up with 9 usability main themes, which can be divided into 26 sub-themes. The main themes and sub-themes discussed during the users testing sessions. Table 2 shows examples of constructs with corresponding experiment session. (See appendix (1)) presents all of these usability themes; the research has interpreted the research findings.

Table 2. Examples of constructs with corresponding experiment session

Main construct	Sample of participants interaction towards usability issues testing
Video issues	The complete agreement of the video structure interface design means that participants were happy to have a short description about the video contain. As discussed, this description helps them to understand what this video is about, and shows that participants were happy to have a combination between videos and short text description of the video. The literature review has highlighted the substantial role of assistant tools used for increasing user's knowledge about related topic [1]. These different techniques clearly showed that participants have different levels of experience and viewpoints. However, all of these suggestions clearly show that long videos were not of interest and should not be included because nobody would be willing to watch them. Short videos with relevant and concise information reflect on the quality of the user experience. Though long videos might contain all the information needed, it might distract the user from the surrounding environment [10].
Menu styling issues	This study shows the two opposing suggestions of the menu style. The first group supported the top style whilst the second group supported the left menu style. Participants interested in seeing the top style was because of its modern style and its common use for interface design. However, the second group argued that the top menu would not appear all the time on the screen, meaning this will increase user actions on the interface. Furthermore, the top menu could distract the user with the browser tool bar, which may allow the user to leave the resource. Moreover, the top menu might not be clear enough for the user against the left menu style. For these reasons the majority of the participants supported the left menu for this resource. Menu style design is considered to be significant in making information on web sites easy to find. Although previous research has suggested a left menu is preferred by users, recent literature also claim that the selections of menu style is a personal choice as long as it is usable [14]
Navigation issues	The difference in navigation methods is important to consider on the interface design as this gives users multiple ways of controlling the interface. Therefore, links to navigations have been used on the study designing interface and mostly are accepted by participants. The study shows the link locations were at the right and clear place. However, extra links for more navigation were mentioned as provided: for instance, 'next' and 'previous' at the end of each page. This means participants could deal with multiple navigation methods or do this through their own design experience. The user getting lost could be the main cause of preventing the use of links for page navigation. Thus, 'breadcrumb' navigation could be a solution for this [32].
Texts issues	Scrolling is the default method to read or see long text on a browser. However, the study shows that some participants support short text on the interface by using the collapse and expand method '+,-'. Those participants wanted to have a clear interface design and be presented with only the important information, with an additional option to expand the information. Furthermore, this was also mentioned as unnecessary information only. All of them agreed that some information should be hidden. In this study, there were three participants who argued that all including information is important to read and should appear all the time; otherwise, some users would not read some sections or would get lost somewhere. Johnson argued various advantages and disadvantages of using scrolling on the design [26]. The combination between these two techniques is expected to be more useful and will improve usability; however, consideration is given to which information will be hidden and which information will be appeared.

4.2 Enhance the usability evaluation learning capacity

The present work has identified various new themes, as highlighted by the study subjects. Table 3 shows the list of new themes identification and interpretation during the user testing sessions.

Table 3. New themes identification and interpretation

New identified themes	Interpretation of the themes identified
Lack of Information	This feedback is clearly shows that some participants are interested in having extra information and additional topics, also its way increase their awareness of decision making[4]. The resource should targets both novice and expert users, thus including and advance topic should be planned and take it as a separate study. Researcher needs to review the topics and meet users in deciding how to integrate this on the main resource.
Contact E-mail	This is known as utility navigation feature and is considered to be one of the activities strongly impacting user satisfaction with the design [17]. This suggestion is one of the most important feedbacks. This suggestion means the resource updating will be regularly and based of the users using. We must keep on touch with users all the time and create an email or contact form for any further suggestions and feedbacks.
References Design Solution	This evaluation study allows users to be involved in the design process by creating suggestion to reinstruct the design. A references section is one of the sections where participants are given some examples for redesign. This means some users are willing to be involved in the design process by giving design suggestions. These suggestions are considered on the next version of the software.
Text and Reference Integration	The integration between the contents and references is important to keep the user related with the original sources for the content. This method also will reduce the time of learning about references between the lists of references. However, this integrating could be way to distract the users with a lot of references links. The searching tool could be a solution instead of the integration, thus we should planning to add this service and well presented on the further version of the resource.

4.3 Gathering of specifications and end-users' feedback

Users' satisfaction themes

At the end of the user testing sessions, participants were asked to complete a user satisfaction questionnaire. Table 4 shows the participants' agreed percentages in regard to the dEv interface elements. This study show that participants were in complete agreement that dEv has clear structure, easy menu style, enough content to understand the topic and the images that provided are helpful too. However, 70% of the study participants agreed that dEv provides an easy navigation. Extra information about each topic is included as references, where these references have been placed as the part of the topic main pages. In total, 70% of the participants rated these

references as helpful references, which encouraged them to explore the topic in depth; in contrast, 10% disagreed and 20% were undecided. However, only 60% agreed that references should be placed at the right position on the interface whilst 10% of them disagreed. The study results show that 80% of the participants agreed that the links provided were clear and easy to find; however, 20% of them rated this as unclear. Using videos on the dEv resource were rated as a useful way of understanding the topic by 80% of the study participants whilst the rest 20% remained undecided. However, 60% of the study participants agreed that the videos provided were helpful and reduced learning time, whereas 10% were disagreed and 30% were undecided in terms of whether or not these videos were helpful and the right choice.

Table 4. Percentage of agreed statements

Statements	% Agree
Clear interface structure	100%
Easy navigation	70.0%
Menu Style	100%
References position	60.0%
Content structure helps me to clearly understand the presented topic	100%
Using links through text to jump between different topics is obvious	80.0%
References encourage me to expand the topic for more information	70.0%
Using images is helpful to understand the topic	100%
Using videos is helpful to understand the topic	80.0%
The videos provided reduced learning time	60.0%

Overall satisfaction is an important goal when applying the questionnaire. The participants were asked to rate their overall satisfaction with three elements: the design of the software interface, the appearance and the usability. The results show that, overall, 90% of the study participants were satisfied with the design of the software interface whilst 10% were neutral. The software appearance was rated as satisfied by 80% of the participant; however, 10% of the participants were dissatisfied, whilst the same percentage were neutral. The majority of participants (90%) were satisfied with the usability level of the dEv software; the rest (10%) were dissatisfied and claim it should be improved (see Table 5).

Table 5. An overall satisfaction with dEv resource

	Dissatisfied	Neutral	Satisfied
Software Interface	0 (0.0%)	1 (10.0%)	9 (90.0%)
Appearance	1 (10.0%)	1 (10.0%)	8 (80.0%)
Usability	1 (10.0%)	0 (0.0%)	9 (90.0%)

5 Discussion

This study was conducted in order to evaluate the first version of the dEv resource and accordingly come up with a new improvement planning and how the awareness impacts the decision making. The dEv resource has been built based on multimedia (videos with words and images) and links (either navigation or references links). Thus, some usability problems or improvement suggestions are expected from the study participants. The following list provides more discussion on the study findings providing support for the improvement of UEMS important understanding, as well as that of the user's feedback and the usability concept.

As found in this research, participants have an interest in everything being as short as possible, with most of them making suggestions or comments on the long text and videos. Participants were not completely satisfied with the length of videos. Thus, they came up with three different solutions to reduce the video time. These three suggestions clearly show that most of the study participants were unhappy with long videos, with short videos more acceptable. Learning cognitive load is valuable and should be minimised on the learning resource. [35] State that 'cognitive load is a central consideration in the design of multimedia instruction'; thus, learning cognitive load should be reduced and they summarise number of ways that can be solving for this challenge and reduce the cognitive overload. However, at times, short content is inadequate in terms of presenting the learning topic and therefore affects understanding. This short content support could affect the understanding pertaining to UEMS importance amongst developers. It is recognised that one solution provided through the application of the dEv model to support the view on content length is the inclusion of summary alongside text and video, affecting the understanding of UEMS topics amongst participants. The study results show that participants were happy with the structure and considered it a good approach centred on gaining improved insight into the UEMS topics.

Most of the users testing issues have produced based on two against groups that argued and came up with two different suggestions, also various subjects made reference to suggestions without providing a rationale for such. These differences in perspectives stem from the viewpoints of subjects and their own experience, which commonly affect their view. As an example there were two groups of references up for argument: on the main interfaces or moved from the main interface as a folder on the main menu under each topic. Furthermore, there were two groups of participant against each other in the use of colours on the interface design. The group supported the use of many colours whilst the second group supported the use of simple and formal colours (black and grey). This clearly shows that the study results are influenced by the mind-set of the developers. In order to avoid this, it was considered in the dEv resource that developers need to apply the UEMS on their products at the earliest stage of the development process and gather a larger number of views from the end user. This is one way of affecting the mind-set of the developers and allowing them to utilise all usability suggestions and remain with the majority. Accordingly, the subsequent version of the resource will adopt the recommendations agreed upon by most of the user testers in mind of achieving a product that is easy to use. Accordingly, the primary garnering of user feedback data will influence the decision-making of the developer for future development planning.

Throughout the user testing stage, various recommendations were made by the participants of the study. The various arguments between the subjects in various situations emphasises the need to complete a usability evaluation. Moreover, many of the studies supported the view that software developers are able to complete the usability assessment approaches [46]. The dEv learning resource was satisfied amongst 90% of them as usable learning resource, meaning it is recognised as a viable way of improving knowledge amongst developers concerning the usability assessment methods towards achieving a usable software. Furthermore, this study sought to evaluate the first version of the resource. This evaluation adopted a number of the evaluation strategies presented on the dEv resource, such as thinking aloud and questionnaires. The presenting results of the work emphasise how the preliminary stage of user involvement is essential and have a notable influence on the decisions of the developer in achieving usable software.

In an effort to improve the understanding of decision making and usability amongst the participants, two factors need to be taken into account, namely trust and credibility. Accordingly, credibility and trust are two important factors where learning resources should be met to allow the user to continue with the information. The dEv learning resource is concerned with these two factors in mind of encouraging users to use the product as a learning resource. Thus, the references of each topic have been placed as part of the main interface for each topic. During the user testing, participants were in complete agreement about the usefulness of including these references on the learning resource. Otherwise stated, subjects showed confidence in regard to providing content that also influences them to revisit for more resources later on.

The assistant tools and models also are helpful in increasing user knowledge on the related topics and decision making [1, 3, 31]. Moreover, some individuals sought to expand data so as to garner more information about the dEv content, with some also investing time into creating a new suggested structure for video visualisation and seeking to provide a utility navigation feature. Furthermore, when the subjects devised the approach (+,-) in mind of decreasing the content length, it became apparent that the dEv model is a way of improving the overall understanding of usability. Moreover, this emphasises that they are able to make decisions in regard to design usability.

6 Conclusion

The key element in the design of software is usability, with usability improvement also fundamental in the development process. Developers undergoing training on UEMS is essential so as to ensure their decision-making concerning software usability is encouraged. Nonetheless, creating such learning resources is not a simple task. In this work, we examined the effects of learning resources (dEv) on software usability, as well as on the usability decisions of developers. Accordingly, the resource was designed in line with particular specifications garnered throughout prior works. This study carried out various evaluation methods in an effort to gather the study data.

This study provides a key contribution concerning the research area's knowledge by creating a learning resource that encourages developers in the application of UEMS and to enhance the decision-making of usability amongst developers. The study findings emphasise that the learning resource influences software developers on the general usability perspective. More specifically, developers are well positioned to complete usability assessments on their products and make choices in regard to their overall usability. Learning resources that are designed in line with particular requirements may have an influence on UEMS importance and usability understanding. Furthermore, the study results emphasise the fact that the involvement of users in the earlier phases are fundamental when seeking to ensure the usability of the software is improved.

One of the study's main limitations is the fact that 12 participants in the UK were responsible for the empirical data. Such a small sample therefore means the findings cannot be generalised; therefore, subsequent works should make use of a larger sample of subjects in different industries so as to establish a more in-depth learning resource that is able to promote UEMS-related understanding amongst developers, in addition to their overall decision-making capacity.

7 References

1. Aberg, J., Shahmehri, N.: The Role of Human Web Assistants in E-Commerce: An Analysis and a Usability Study. *Internet Res.* 10, 2, 114–25 (2000).
2. Abras, C. et al.: User-centered design. Bainbridge, W. *Encycl. Human-Computer Interact.* Thousand Oaks Sage Publ. 37, 4, 445–456 (2004).
3. Alkhuraji, A. et al.: Knowledge network modelling to support decision-making for strategic intervention in IT project-oriented change management. *J. Decis. Syst.* 23, 3, 285–302 (2014).
4. Alkhuraji, A. et al.: New structured knowledge network for strategic decision-making in IT innovative and implementable projects. *J. Bus. Res.* (2015).
5. Almansour, F., Stuart, L.: Promoting the use of Design Evaluation Techniques within Software Development. In: *BCS HCI*. (2014).
6. Ardito, C. et al.: An approach to usability evaluation of e-learning applications. *Univers. Access Inf. Soc.* 4, 3, 270–283 (2006).
7. Ardito, C. et al.: Investigating and promoting UX practice in industry: An experimental study. *Int. J. Hum. Comput. Stud.* 72, 6, 542–551 (2014).
8. Bargas-Avila, J.A. et al.: Intranet satisfaction questionnaire: Development and validation of a questionnaire to measure user satisfaction with the Intranet. *Comput. Human Behav.* 25, 6, 1241–1250 (2009).
9. Bevan, N.: Cost-Benefit Framework and Case Studies. In: Bias, R.G. and Mayhew, D.J. (eds.) *Cost-Justifying Usability An Update for an Internet Age*. pp. 575–600 Elsevier (2005).
10. Boiano, S. et al.: Usability, design and content issues of mobile apps for cultural heritage promotion: The Malta culture guide experience. *arXiv Prepr.*

- arXiv1207.3422. (2012).
11. Bowler, L. et al.: Issues in User-Centered Design in LIS. *Libr. Trends*. 59, 4, 721–725 (2011).
12. Brézillon, P. et al.: Lessons Learned from Three Case Studies. *J. Decis. Syst.* 17, 1, 27–40 (2008).
13. Bruun, A., Stage, J.: Barefoot usability evaluations. *Behav. Inf. Technol.* 33, 11, 1148–1167 (2014).
14. Burrell, A., Sodan, A.C.: Web Interface Navigation Design: Which Style of Navigation-Link Menus Do Users Prefer? In: *Data Engineering Workshops, 2006. Proceedings. 22nd International Conference on Data Engineering Workshops*. pp. 1–10 (2006).
15. Cook, D.A., Dupras, D.M.: A practical guide to developing effective web-based learning. *J. Gen. Intern. Med.* 19, 6, 698–707 (2004).
16. Dix, A. et al.: *Human Computer Interaction*. Prentice Hall, USA (2004).
17. Farrell, S.: Utility Navigation: What It Is and How to Design It, <http://www.nngroup.com/articles/utility-navigation/>.
18. Ferre, X. et al.: Usability basics for software developers. *IEEE Softw.* 18, 1, 22–29 (2001).
19. Fox, D. et al.: Agile Methods and User-Centered Design: How These Two Methodologies are Being Successfully Integrated in Industry. In: *Agile 2008 Conference*. pp. 63–72 IEEE (2008).
20. Gould, J.D., Lewis, C.: Designing for Usability: Key Principles and What Designers Think. *Commun. ACM*. 28, 3, 300–311 (1985).
21. Gould, S., Powell, P.: Understanding Organisational Knowledge. *J. Decis. Syst.* 13, 2, 183–202 (2004).
22. Han, S.H. et al.: Usability of consumer electronic products. *Int. J. Ind. Ergon.* 28, 3–4, 143–151 (2001).
23. Holzinger, A.: Usability engineering methods for software developers. *Commun. ACM*. 48, 1, 71–74 (2005).
24. Howarth, J. et al.: Supporting novice usability practitioners with usability engineering tools. *Int. J. Hum. Comput. Stud.* 67, 6, 533–549 (2009).
25. Humayoun, S.R. et al.: A Three-Fold Integration Framework to Incorporate User-Centered Design into Agile Software Development. In: *Human centered design*. pp. 55–64 (2011).
26. Johnson, T.: Evaluating the Usability of Collapsible Sections (or jQuery’s Content Toggle), <http://idratherebwriting.com/2013/03/25/evaluating-the-usability-of-collapsible-sections-or-jquery-s-content-toggle/#comment-2029521352>.
27. Jokela, T. et al.: The Standard of User-Centered Design and the Standard Definition of Usability: Analyzing ISO 13407 against ISO. In: *In Proceedings of the Latin American conference on Human-computer interaction*. pp. 53–60 ACM (2003).
28. Keinonen, T.: Protect and appreciate – Notes on the justification of user-centered design. *Int. J. Des.* 4, 1, 17–27 (2010).
29. Kräenbring, J. et al.: Accuracy and completeness of drug information in Wikipedia: a comparison with standard textbooks of pharmacology. *PLoS One*. 9, 9, e106930 (2014).

30. Kujala, S.: User involvement: A review of the benefits and challenges. *Behav. Inf. Technol.* 22, 1, 1–16 (2003).
31. Lutz, M. et al.: Methods and applications for IT capacity decisions: Bringing management frameworks into practice. *J. Decis. Syst.* 22, 4, 332–355 (2013).
32. Magazine, S.: Breadcrumbs In Web Design: Examples And Best Practices, <http://www.smashingmagazine.com/2009/03/breadcrumbs-in-web-design-examples-and-best-practices/>.
33. Maguire, M.: Methods to support human-centred design. *Int. J. Hum. Comput. Stud.* 55, 4, 587–634 (2001).
34. Marc, M.: 7 Benefits of Agile and User Centered Design, <https://www.thoughtworks.com/insights/blog/agile-and-user-centered-design>.
35. Mayer, R.E., Moreno, R.: Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educ. Psychol.* 1520, 38, 43–52 (2010).
36. Najafi, M., Toyoshiba, L.: Two Case Studies of User Experience Design and Agile Development. In: *Agile 2008 Conference*. pp. 531–536 IEEE (2008).
37. Nielsen, J.: *Usability Engineering*. Morgan Kaufmann (1993).
38. Nielsen, J., Mack, R.L.: *Usability Inspection Methods*. John Wiley & Sons Inc, United States (1994).
39. Preece, J. et al.: *Interaction Design: Beyond Human-Computer Interaction*. John Wiley & Sons Ltd, United States (2002).
40. Ramli, R. bt M., Jaafar, A. bt: e-RUE : A cheap possible solution for usability evaluation. In: *2008 International Symposium on Information Technology*. pp. 1–5 IEEE (2008).
41. Rannikko, P.: *User-Centered Design in Agile Software Development*. University of Tampere (2011).
42. Rosenbaum, S. et al.: A toolkit for strategic usability. In: *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '00*. pp. 337–344 ACM Press, New York, New York, USA (2000).
43. Salah, D.: A framework for the integration of user centered design and agile software development processes. In: *Proceeding of the 33rd international conference on Software engineering - ICSE '11*. p. 1132 ACM Press, New York, New York, USA (2011).
44. Sharp, H. et al.: INTEGRATING USER-CENTRED DESIGN AND SOFTWARE ENGINEERING: A ROLE FOR EXTREME PROGRAMMING? In: *BCS-HCI Group's 7th Educators Workshop: Effective Teaching and Training in HC*. pp. 1–4 (2004).
45. Shneiderman, B. et al.: *Designing the User Interface: Pearson New International Edition: Strategies for Effective Human-Computer Interaction*. Pearson Education Limited, United Kingdom (2013).
46. Skov, M., Stage, J.: Training Software Developers and Designers to Conduct Usability Evaluations. *Behav. Inf. Technol.* 31, 4, 425–435 (2012).
47. Skov, M.B., Stage, J.: Supporting problem identification in usability evaluations. *Proc. 17th Aust. Conf. Comput. Interact. Citizens Online Considerations Today Futur. Comput. Interact. Spec. Interes. Gr. Aust.* 1–9 (2005).
48. Song, J.H., Zinkhan, G.M.: FEATURES OF WEB SITE DESIGN,

PERCEPTIONS OF WEB SITE QUALITY, AND PATRONAGE
BEHAVIOR. In: ACME Proceedings. pp. 106–114 (2003).

49. Stone, D. et al.: User Interface Design and Evaluation. Morgan Kaufmann, United States (2005).
50. Vredenburg, K. et al.: A survey of user-centered design practice. In: Proceedings of the SIGCHI conference on Human factors in computing systems Changing our world, changing ourselves - CHI '02. pp. 471–478 (2002).

Appendix:

Table 6: Main themes and subtheme descriptions and research finding interpretations

Main Theme	Subtheme	Description	Research Interpretation for the finding
video	Clear visualisation	Videos have a specific structure that integrates the clips and short summaries of the video. Participants said that ‘video structure is clear and contains important information that well described the video’. All the participants agreed that structure is clear and understandable, especially before running the clip to understand the video content	The complete agreement of the video structure interface design means that participants were happy to have a short description about the video contain. As discussed, this description helps them to understand what this video is about, and shows that participants were happy to have a combination between videos and short text description of the video. The literature review has highlighted the substantial role of assistant tools used for increasing user’s knowledge about related topic [1].
	Links to jump	Some of the included videos have long clips that could be undesirable as a whole; however, participants suggested that links to jump are better in order to avoid unwanted clip parts: for instance <2(2:25-4.00) put link on 2:25 that let the user to jump at this time. Three participants mentioned the same issue.	All participants were interested in watching short videos rather than long videos. Participants mentioned three different techniques to improve the providing videos, which are cutting video, links to jump and directly running a specific part of the video. These different techniques clearly showed that participants have different levels of experience and viewpoints. However, all of these suggestions clearly show that long videos were not of interest and should not be included because nobody would be willing to watch them. Short videos with relevant and concise information reflect on the quality of the user experience. Though long videos might contain all the
	Cut the clip	Long videos containing unwanted durations should be cut to show only the required time. Participants said ‘cut the video and make it smaller’. Four participants supported cutting the videos in order to show only the required clip.	

Main Theme	Subtheme	Description	Research Interpretation for the finding
	Run specific section	Long video that contains unwanted sections should be included however let the video automatically running the required time then stop. Stop reminder is required to include that remind the user stop the clip and keep the time appear on the full screen. Two participants mentioned that a stop reminder should be included.	information needed, it might distract the user from the surrounding environment [10].
Top Menu style	Modern	There was only one participants who mentioned having a top menu instead of a left menu.	This study shows the two opposing suggestions of the menu style. The first group supported the top style whilst the second group supported the left menu style. Participants interested in seeing the top style was because of its modern style and its common use for interface design. However, the second group argued that the top menu would not appear all the time on the screen, meaning this will increase user actions on the interface. Furthermore, the top menu could distract the user with the browser tool bar, which may allow the user to leave the resource. Moreover, the top menu might not be clear enough for the user against the left menu style. For these reasons the majority of the participants supported the left
	Not appear all time	Participants mentioned that the top menu would not be available all the time, which will annoy users.	
	Distract	Top menus will disturb browsing windows, meaning users frequently attempt to click on the browser bar rather than the main menu bar.	
Left Menu style	Clear and understandable	Eight out of ten participants agreed that the left menu is clearer and more understandable. However, one participant suggested a list of links rather than a menu as it would be more stylish.	

Main Theme	Subtheme	Description	Research Interpretation for the finding
	Naming	<p>The menu section naming needs to be more clarified and should better describe the topic. Four participants supported this issue whilst one made the following suggestion:</p> <p>‘What is it?’ Instead of what?</p> <p>‘How to use it?’ Instead of how .</p>	<p>menu for this resource. Menu style design is considered to be significant in making information on web sites easy to find. Although previous research has suggested a left menu is preferred by users, recent literature also claim that the selections of menu style is a personal choice as long as it is usable [14]. Essentially, all of these two suggestions of menu style are commonly used; however, the tradition left menu style will fit on this learning resource, as supported by participants. Furthermore, there were some suggestions on the menu items naming, meaning participants were interested in improving the menu and keeping it as the appropriate style of the learning resource.</p>
References	Distract	Reference on the main home page is distracting to the user.	<p>Including references in the design content (text, image, video etc.) is important to give software content more credibility and allow application users to build up trust for the contents. This technique is commonly used on web applications: for example Wikipedia provides a list of references on the same page as the content. There are conflicts pertaining to Wikipedia’s accuracy of information; however, Kräenbring <i>et al.</i> (2014) suggest that Wikipedia is an accurate and complete source of study [29].</p> <p>The study software placed the references as a part of the main interface. This included the reference</p>
	No need	Some users do not need the references to appear all the time because they don’t need for them. Three participants highlighted this proposal.	
	Too much data	References mean the home page loads too much data on the screen. Users are required to focus on important data only. Three participants supported this suggestion.	
	Easy to find	References placed on the main page make it easier to find references if needed. Four	

Main Theme	Subtheme	Description	Research Interpretation for the finding
		participants supported this issue.	of the chosen topic only. There were two groups against each other: the first group supported the view that references should not be included as a part of on the main interface; the second group supported putting references with some changes to the structure. Each group came up with some reasons as to why their choice was supported. Participants who suggested leaving the reference on the main interface mentioned that is easy way to find further information without any extra effort. However, the second group mentioned that references should be somewhere out of the main interface because it's too much data on the screen, which will distract the user from reading the important parts. Furthermore, these references are not requested all the time, meaning it is appropriate to move them somewhere else.
	Deduce user effort	Participants supported the right references because this reduces users' efforts and actions on the interface.	
Colours	Black and grey	Black and grey interface colours are supported by three participants, who mentioned that using simple and limited colours gives more clarity. In addition, these two colours are formal and commonly used, which can be read form any devices and formats.	The design features, such as colours, are referred to as a factor that enhances software usability [48]. The study participants came up with two different views on the interface and text colours. The first view supported the simple and formal way of using black and grey colours only. These participants who supported this suggestion intended to be more simple and clear. The second group supported the use of multiple colours on the interface and mentioned the interactive design as the main factor for keeping users dealing with
	Colourful	Four participants were interested in having a colourful interface rather than black and grey (simple). They mentioned that using more colour is attractive to the reader.	

Main Theme	Subtheme	Description	Research Interpretation for the finding
		However, designers should be careful with colour choices and be consistent.	the interface design. It is true that designers want to allow the user to come back and use it again; however, consistency is important in caring when completing the design. The next version uses colour with various changes in order to be more consistent. Moreover, it is possible to have another version including only black and grey.
Long text	Collapse and expand text	Long text is not suitable; thus, using the collapse and expand method is important. Four participant supported this technique because this method makes the interface clearer and allows the reader to focus on the important content, which also encourages the reader to explore and read the rest of the content. One participant supported this technique; on the other side, however, he mentioned the need to 'keep the important information and hide the unnecessary information that can disturb users'.	Scrolling is the default method to read or see long text on a browser. However, the study shows that some participants support short text on the interface by using the collapse and expand method '+,-'. Those participants wanted to have a clear interface design and be presented with only the important information, with an additional option to expand the information. Furthermore, this was also mentioned as unnecessary information only. All of them agreed that some information should be hidden. In this study, there were three participants who argued that all including information is important to read and should appear all the time; otherwise, some users would not read some sections or would get lost somewhere. Johnson argued various advantages and disadvantages of using scrolling on the design [26]. The combination between these two techniques is expected to be more useful and will improve usability; however, consideration is given to which information will be hidden and
	Scrolling	Three participants mentioned that information should be directly appearing on the screen because this is important information and it cannot be hidden. Furthermore, the scrolling technique will reduce user actions on the screen.	

Main Theme	Subtheme	Description	Research Interpretation for the finding
			which information will be appear.
Images	Reduce long text	Using images that describe the long text is suggested by participants, especially for describing workflow.	Image, charts and graphic are essential for quickly learning a complex topic. Images summarise long text or workflow. The study participants mentioned images need to be considered because they present a lot of information in a simple and short way, meaning users can quickly scan and images are a way of having an interactive design. Some images are included but more will be added on the next version.
	Clarity	Images will make the interface clearer and the information more readable.	
	Time	Images should be supported because these methods will reduce the time of learning.	
Home page and its related pages	Content	The main page provided a short sentence of the topic and each sentence described on separate page. Four participants support the view that each main page information should start the same on its own page. Furthermore, there were some spelling mistakes found.	The consistency of information between the main pages and its related pages are important in order to clearly present the topic. The main page contains a short sentence 'hint' for the topic and the user has the control to explore the topic using menu or links. Therefore, some participants mentioned that the title of the main page should be changed to clearly present a summary page for the topic. Thus, change is considered a high priority and should be updated to improve the level of usability and stop distracting the reader. Cook & Dupras (2004) listed ten guidelines for creating an educational website, suggesting the design of pages should include clear headings, sentences comprising no more than 20 words with a maximum of 5 sentences on each paragraph. Furthermore, each topic should start
	Title	Each topic has presented on one main page (home page) and it's related to many other pages that explore the topic. Three participants were supported that main page title should be changed and call it 'Summary' because this will avoid confusing readers.	

Main Theme	Subtheme	Description	Research Interpretation for the finding
			with a summary before giving more details [15].
Navigation	links and its locations	Participants stated that ‘main page links are stated on the perfect place which is at the end of each section’. This was supported by another two participants. Moreover, participants suggested other links for next and pervious pages at the end of each page, which allows the user to control the pages without using the main menu. One participant mentioned that links are an important way of jumping between topics; however, this could mean the user loses where they are. Thus, designers should find a method for keeping the user informed of the current place: for instance, ‘highlighting the new topic’	The difference in navigation methods is important to consider on the interface design as this gives users multiple ways of controlling the interface. Therefore, links to navigations have been used on the study designing interface and mostly are accepted by participants. The study shows the link locations were at the right and clear place. However, extra links for more navigation were mentioned as provided: for instance, ‘next’ and ‘previous’ at the end of each page. This means participants could deal with multiple navigation methods or do this through their own design experience. The user getting lost could be the main cause of preventing the use of links for page navigation. Thus, ‘breadcrumb’ navigation could be a solution for this [32].
	Links to jump	Four participants supported the jump up links placed at the end of each section on the screen as this will reduce the user’s action from scrolling up.	
	Broken links	There were some broken links found for both internal and external links.	It’s possible to have some broken links for technical problems. Thus, some broken links found for both internal and external links, meaning the participants carefully tested each single point on the interface.