Perspectives on how the quality of e-learning relate to its usability.

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ABSTRACT
The advent of e-learning (or technology enhanced learning) has opened up new frontiers of knowledge in India as much as it has world over. Despite the vast advances made as a direct consequence of this new learning experience, we do not yet have a consolidated methodology for the evaluation of e-learning applications. When evaluating e-learning material (hardware, software, content), it is paramount to consider the tools pedagogic effectiveness, efficiency and usability. This opens up discussions around issues of quality relating to perception and usability of e-learning applications. This paper aims to explore and review the myriad of perspectives arising in literature, centered around the relevance of quality and its implications on usability in e-learning and uses secondary data to explore existing compelling arguments and positions on the subject. The paper opens future work using the identified quality and usability perspectives as a guideline to ascertain their influence on end user perception with respect to a defined demography.

Keywords: Perspectives, E-Learning, Evaluation, Quality, Usability.

INTRODUCTION
E-LEARNING BACKGROUND
As the field of information and communication technology continues on its remarkable growth path, the education sector has adopted a few IT related strategies, a novel advance which has seen a shifting from the conventional way of obtaining and transferring academic knowledge. Technology based/assisted learning from now on referred to as e-learning, which was initially framed as a tool to help end users in distance learning set-ups has become a global game-changer with respect to all manner of learning. E-learning involves the remote communication between an instructor/teacher and student through the use of information technology platforms. This method has been successfully adopted world-over because of a few key factors:

- ICT technologies are universal in all countries. As a result many e-learning software products have interfaces that carry a unified which can be understood independent of language or nationality.
- Electronic exchange of information and data is now an integral part of the lives of this current generation of instructors and learners. In all areas, including those in the most remote and marginalized, information and communication technology tools are now regarded a part of everyday life. This makes using these same tools for academic information transfer a relatively easy shift.
- The modern world has evolved into a very fast and dynamic environment, a key adaptation to thrive involves employing the cheapest and fastest ways to generate and transmit knowledge, and e-learning is one of the tools that perfectly fit this bill.

In this light, e-learning can be viewed as a simple extension that can work independent of or side by side with traditional, formal education methods (daily student/teacher face to face interactions). This method allows end users to freely and independently acquire vast amounts of relevant information from e-books, encyclopedias, social media, video repositories as well as online courses and open educational resources. E-learning is applied in different form, specific to the environment of operation but there are 3 general models:

- A web based instruction model where up to one third (33%) of the time allocated to mastering
the discipline is given in the form of an electronic course. Here the electronic environment has a supplementary role to traditional learning. This can be achieved through the provision of e-reading material, self-testing, online forums and webinars and other projects that could utilize the electronic environment.

- A blended learning, which as the name suggests encompasses both traditional learning and e-based endeavors. Classroom-based activities are complemented by e-learning activities and the e-learning component can take anything between 20-80% of the total allocated time.

- Full-on e-learning, an approach where 90-100% of educational activities take place in an electronic environment. To achieve this, the learning content has to be highly interactive and also provide platforms for real time communication with the teachers and possibly other learners. (Wisneski, Ozogul, Bichelmeyer, 2015), (Gillani, Eynon, 2014).

E-learning provides immediate access and endless options to all learners that access the platforms. It provides easier and efficient learner/instructor environments by totally mitigating time and space limitations. Ideally, internet access alone can guarantee one a world-class education at very minimal costs, from the comfort of their different work stations. E-learning is a tool that will significantly alter the future of education and there is a need to understand how to improve the performance, efficiency and effectiveness: with this in mind it is key to develop uniform frameworks specific to monitoring and evaluating the quality and usability of e-learning. These models should apply globally.

STUDENT PROFILES AND CUSTOMIZATION

The learning process is a long-term engagement and outcomes can be seen after an investment of effort and time. For this to occur, the subject, structure and material must have the ability to sustain the interest of the learner. Different individuals have different profiles and the profile has an impact on performance. (Duckworth, Gross, 2014). E-learning is a tool that can overcome this barrier because e-learning can be adapted to a specific learner, customizing the learning environment. Customization in educational content delivery has the potential to improve the overall quality of the learning process (Liu & Yang., 2005), (Huang et al., 2007), (Chang et al., 2009), (Li et al., 2012), (Chang & Ke., 2013). The content, sequence and pace can be adjusted accordingly to accommodate the learners’ character traits as well as their learning style. It can be challenging to try and understand particular needs of different learners in an attempt to personalize the learning experience accordingly, but if achieved it will surely produce a more effective learning experience. Customization/personalization is a significant quality and usability overlap that can be considered an asset because it will improve most learners’ perception towards e-learning and result in a higher uptake of the educational model (Chae, Shin, 2015)

E-LEARNING ADVANCES

Taking into account the broad definitions of e-learning, mobile learning can be seen as an advance capable of achieving optimum educational advantages. The surfacing of smart phones provides opportunity for both instructors and end users to access e-learning materials and services through handheld mobile devices. This advance is not restricted to location as the devices are mobile. Many new mobile devices have advanced features such as internet browsers, video streamers, high definition colour display screens, this makes learning on these devices possible and practical. (Abachi et al., 2014) Integration of mobile devices in e-learning service delivery carries a host of benefits, namely ubiquity, mobility and freedom. It also provides a platform for real-time instructor-learner interaction, communication and data sharing. (Motiwalla, 2007). These advances can only be usefully exploited in the e-learning context when there is an understanding of end user’ perceptions and perspectives of the mobile e-learning system. Acceptance is easy when one feels that the service and the content are high quality. (Park et. al., 2012). In this light the usability of e-learning depends on the quality factors that are considered when developing it. These factors for the most part can be built off the learners perspectives and perception of e-learning through the use of mobile devices. Quality factors also influence end users desire and intention towards continued use of the e-learning platforms because satisfaction is critical for the establishment of long term client relationships (Patterson et. al., 1997).
QUALITY IN E-LEARNING

Defining the ‘quality’ of education is a complex process. One would have to take a comprehensive look at a number of factors like environmental suitability, adequate service provision, content, availability, flexibility, speed, timeliness, these represent the process. In addition one needs to assess the outcomes from the educational experience because they are also a reflection of the said quality standards. (Agariya & Singh, 2012). The quantification of quality in an e-learning setup on the other hand is to an extent complex because e-learning broadly defined, encompasses a number of varied forms of technology supported learning and involves applying knowledge, educational technology and information, linking people with educational resources as we as each other for the purpose of formal or informal education. (Ehlers et al., 2012)

Quality in an e-learning system can be evaluated from many vantage points, one can consider the product quality and another assesses the quality of the overall learning experience. The product quality can be further broken down into 3 aspects, system quality framework, information quality framework (content) and service quality framework. Quality can in e-learning can be viewed either as the quality of education provided through the use of e-learning tools or it can also refer to the quality of the combined inputs and subsequent outputs (Teodora et al., 2013)

E-LEARNING AND USABILITY

Usability refers to the extent that a system or product satisfies with effectiveness and efficiency, the needs as well as specifications of users. Usability is the basis upon which users accept and adopt a product or system. In an e-learning scene (with particular reference to human-computer interaction), usability hinges on how well the learners can employ the full functionality of the system. (Nielsen, 1993), (Teo et al., 2003). According to ISO 1998 usability can be deemed as defined above in a specified context of use and is related to the following:

- Product use (efficiently, effectively to a point of satisfaction in a particular context of use.)
- The platform user interface and interaction modalities
- The product development process
- Organizational capability towards application of user-centered design.

In a nutshell, usability is primarily focused on making a system easy to learn as well as use.

LITERATURE REVIEW

DIFFERENT PERSPECTIVES ON E-LEARNING QUALITY

The term e-learning is used in reference to a number of different forms of technology supported learning systems. It can be characterized as the application of information, knowledge and educational technology. E-learning links people to each other or to educational resources all for the purpose of education in an either formal or informal learning setup (Ehlers & Hilera, 2012).

(Teodora et al., 2013) suggest that e-learning quality should be examined in two contexts that are, quality through e-learning and the quality of the e-learning itself.

(Dobre, 2012) puts forward the postulation adopted from Auvinen and Peltonen, which asserts that we can define the quality of education from three perspectives and these are:

- Technological
- Economic
- Pedagogical

In the model, quality was evaluated in retrospect. The parameters used to evaluate quality included course quality and pre-defined course outcomes. The approaches evolved to ones that were more process focused. (Bremer, 2012) outlined an evaluation of the quality of the overall process in addition to evaluating the outcome.

A more comprehensive assessment of quality in higher education was defined by (Thair et al., 2006) where combinations of activities need to be carried out to support the quality model. These activities include:

- Improving core activities (institutional)
• Aligning resource’s, budgets and activities within the bounds of the strategic plan
• A demonstration of innovation and leadership in all activities
• Active exploration of students and other stakeholders’ needs
• Intentional investment towards focused human resources development
• Making data driven decisions (using acquired information and knowledge)
• Achieve better outcomes.

Defining quality in e-learning is a complex endeavor and as a result when reviewing literature, one will run into a number of alternate models, frameworks as well as recommendations for e-learning quality assurance. A few of the frequently cited ones include (Zhang & Cheng, 2012), (Masoumi & Lindstrom, 2012), (Saatz & Kienle, 2013), (Udo et al., 2011) and (Kirs, 2011)

Early initiatives on e-learning quality assumed that the quality principles of traditional classroom education could be superimposed and apply to technology enhanced learning. The key deliverable in this approach was based off well-designed learning activities being a precursor for ensuring success regardless of the complimentary means (the presence or absence of and additional technology). This approach falls short because e-learning is not an alternate implementation method for traditional classroom teaching; E-learning overall is a new approach to education and quality assurance frameworks must take this fact into account. (Masoumi & Lindstrom, 2012)

Assessing the level of quality can be done in one of two ways. It can be achieved through a benchmarking process or by the specification of standards. Benchmarking compares the performance and achieved results of an evaluated entity against the same for an entity that is operating under comparable conditions. In a case where standards are defined, comparing them with set standards sets performance. (Oliver, 2005)

Different perspectives on quality necessitate the need for uniform evaluation parameters. There are a number of accepted standards and recommendations for quality in e-learning. A few examples include the Learning Technology Standards Committee (LTSC), The Quality Assurance agency (QAA), The Institute for Higher Education Policy, Learning Object Metadata (LOM). (Oliver, 2005). Other workers, (Al-Mushasha & Nassuora, 2012), (Yee, 2013) and (Agariya et al., 2012) have written on best practices in e-learning, these currently can potentially be used as performance standards.

PERSPECTIVES ON USABILITY

Usability in the e-learning context can be characterized as the effectiveness, adequacy and fulfillment with which users can accomplish learning related objectives in a specific discipline through a specific device or learning resource. Usability is closely related to accessibility, the more likely one is to access a resource, the higher the likelihood that it will be more usable to them and the converse is true. Usability and accessibility have a direct impact on the pedagogical adequacy of e-learning suites, this applies to all learners but has a more dramatic impact on crippled learners. (Cooper et al, 2007)

The use of technology in learning should be a tool to empower to users and not a hindrance or barrier to access. The fundamental aspects for usable design should be considered when developing e-learning materials to facilitate better usability and uptake from all users. Usability is therefore a core necessity to simplify life for all users of technology enhanced learning and should not be viewed as a battle only set aside for those with compelling accessibility necessities (Jeffels, 2005)

The e-learning framework on usability takes into consideration, two core perspectives: technical usability and pedagogical usability. Technical usability focuses on interventions that guarantee inconvenience free interactions with the e-learning frameworks whereas pedagogical usability has a hand in supporting the actual learning processes. The two aspects however are intricately interwoven and they tap into the learner’s psychological assets (Melis et al., 2003)

Pedagogical usability takes into account whether or not the content, tools, software interface and the assignments on the learning platforms facilitate the best outcomes for different learners in different setting in accordance to the pre-set pedagogical goals (Tervakari et al., 2002)

THE ISO 9126 MODEL IN THE CONTEXT OF E-LEARNING

ISO/IEC 9126 can be adopted to evaluate the quality of e-learning software. In this regard, ISO 9126
defines quality, as ‘the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs.’ This system puts forward a quality model that accounts for six quality characteristics:

- **Functionality**: The software’s ability to fulfill the users stated and implied needs in a specific context of use. (How the software operates to meet the perceived need)
- **Reliability**: The ability of the software product to perform consistently under stated conditions for a stated period of time.
- **Usability**: The software, characteristic, which gives it visual appeal and ensures that it can be understood, learned and used under specified conditions. (Effort required for use)
- **Efficiency**: The capability of the software to provide desired performance, related to amount of resources used, under stated conditions
- **Maintainability**: The capability of the software product to be modified, corrected, improved or adapted to environmental, functional specific general or requirement changes. (Effort required to modify)
- **Portability**: The feasibility to transfer the software from one environment to another. Environment could imply organizational, hardware or software.

These quality factors cannot be directly measured or evaluated and will have to be assessed in terms of more objective sub-characteristics. Different process are put into evaluating the different characteristics for example, functionality is highly specific to the particular educational domain, maintainability on the other hand can only be evaluated by the software developer or a third party with access to the source code (technical documentation), portability however does not require domain specific expertise to assess (Valenti, 2002).

This suite of standards provides a framework for the evaluation of software quality, it does not prescribe specific requirements but on the contrary describes a quality model that can be applied to all software (e-learning software included). This standard introduces the quality concept, ‘quality in use’ which refers to the users point of view.

Using this standard, two models of software quality are specified:

a) The quality characteristics, Functionality, reliability, effectiveness, usability, maintainability and portability are used to model both internal and external software quality.

b) Usability/Quality in use is dependent on a different set of characteristics: effectiveness, productivity, security and satisfaction.

**E-LEARNING QUALITY FROM AN END USERS PERSPECTIVE**

The complexity of the quality concept can be conceptualized in a systematic way. One has to acknowledge that basis of the e-learning quality complexity; there are different meanings of quality, different quality perspectives as well as different educational process levels to which quality applies. (Ehlers, 2002), (Ehlers, 2003) (Ehlers, 2004). We can further distinguish quality into five different levels, namely context, structure, process, output and impact quality. In each of these subsets, quality applies differently. A simple scheme is shown below to demonstrate the quality complexity.
Taking into account all the perspectives mentioned in this paper on quality, a definition of quality would mean one positions themselves centrally in a multi-dimensional space as fig. suggests. We do not have a universally applicable, standard perspective for the development or assurance of quality. It is imperative that at every attempt, quality development has to take different perspectives into account.

Figure 2: Different dimensions of the quality concept in e-learning (cf. Ehlers 2004)

When we focus on the end user perspective, we move away from standardized learning processes and move towards customized training biographies (Robinson & Arthy 1998). A student suited e-learning quality framework looks at the importance of knowledge and information, its acquisition and application as well as the ability to use technological tools to generate, process and communicate this knowledge and information. These are skills that are developed as per personal preference, considering different usage contexts. (Castels, 1996)

Quality from the end user’s perspective must be viewed as a co-production process between the learner and the learning environment. This means that the learning process is not something passed on to the student by an e-learning provider but a product of their mutual interaction. With this view, the e-learning...
processes do not exclusively influence the outcome of the learning process. Education in this instance is not a commodity that can be purchased or traded; learning consists of a process that the end users have to carry out by themselves. Quality in this regard will have to be defined at the end point of the learning service where the system interacts with the student. This does not mean the whole quality framework be built solely around the end user’s preference and perspectives, rather take these as a starting point leading to quality development of all the other areas. The figure below shows four different components that can be used to conceptualize a learning environment incorporating different perspectives of quality from the end user vantage point. (Ehlers, 2004).

![Diagram showing the relationship between student, learning environment, quality, and topic]

_A figure showing the end user position in a learning environment (Fricke, 1995)_

A quality concept built around the learner’s perspective has to be comprehensive and should not only focus on aspects of instructional and technological interface design. Future work on e-learning quality development should not be built around a general criterion for all learners. Based on the above literature review, quality and usability in e-learning are two components that can not be viewed in isolation of each other. Their inter-dependence has been a recurring theme cutting through the different perspectives outlined by most of the reviewed work. When the sub-characteristics of quality are explored, it becomes apparent that the two should be fused to give a more holistic understanding on their relationship. To understand this picture one must step back and make an assessment from the viewpoint of the end user. Quality influences usability, whereas, usability is dependent on quality. These two converge at end user and can be assessed both qualitatively and quantitatively, primarily using learner satisfaction algorithms. The next section of this paper will focus on this association and how it helps us in formulating a framework for the inclusive evaluation of quality from a usability standpoint.

**RELATIONSHIP BETWEEN QUALITY AND USABILITY**

Quality refers to the completeness of the features on a product, these features have a bearing on the products ability to satisfy a user’s needs, (both stated and implied). Usability can be viewed as a measure of the extent to which the said product actually meets the specific needs in an effective way to the satisfaction of the user in a defined context. From a simpler perspective, usability is the assessment of a quality aspect/s with relation to a specified end-user-task scenario. From the literature review extract we can assert that usability is based on a specific user’s view on a
product’s quality and can be assessed from the point of actually using the said product whereas quality is based on the properties of the product that make it usable.

This being said, usability is a user specific measurement. We can therefore state that:

The relationship between quality and usability depends on the profile of the user.

An e-learning application can only be termed usable to a particular end user if it meets a specific need that is relevant to the user. From one user, the core deliverables could be portability because they are frequently moving (porting) the product, whereas for another a key usability factor would be maintainability because they are entrusted with the task of maintaining a software platform.

To effectively account for usability based on the quality factors, it is essential to break down the broad sub-categories outlined in the ISO scheme represented in figure 1 above and decompose them down to a specific context of use. The aspect addressed should be both measurable and verifiable. Usability can then be referred to as a measure of the effectiveness, relating to the accuracy and completeness with which the said goals have been achieved.

The inclusion of the usability factor makes the ISO quality model more complete and eliminates the weaknesses seen in comparable models such as McCall’s model, the Boehm model (Behkamal et al., 2008). The table below explains and summarizes how quality and usability relate to each other.

Table 1: Characteristic and sub-characteristics of the ISO 9126 (Adapted from Chua, 2004)

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<th>Characteristic</th>
<th>Quality Aspect</th>
<th>Specific Usability Probe</th>
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| Functionality  | Suitability, Accuracy, Interoperability, Compliance, Security | • Is the software able to perform required tasks?  
• Does it give the expected results?  
• Can it interact with other systems?  
• Does it meet compliance standards?  
• Does the system prevent unauthorized access? |
| Reliability    | Maturity, Fault tolerance, Recoverability, | • Have faults been identified and eliminated?  
• Is the software able to handle errors?  
• Can the system recover lost data and resume working after failure? |
| Usability      | Understandability, Learnability, Operability, Attractiveness | • Can a first-time user understand how to use the system easily?  
• Can a user learn how to use the system easily?  
• Does the user require a lot of effort to use the system?  
• Is the interface pleasing to behold? |
| Efficiency     | Time, Behavior, Resource utilization | • How fast is the system response?  
• How efficient is the system resource utilization? |
| Maintainability| Analyzability, Changeability Stability, Testability | • Can faults be easily diagnosed?  
• Can the software be easily modified?  
• Can the software continue functioning if changes are made?  
• Can the software be tested easily? |
| Portability    | Adaptability, Installability, Conformance, Replace ability, | • Can the software be moved to other environments?  
• Can the software be installed easily?  
• Does the software comply with portability standards?  
• Can the software easily replace other software |

DISCUSSION
Having high quality e-learning materials and applications relates directly to high usability, subsequently leading to increased user satisfaction. Increased user satisfaction is related to elevated levels of intention to use, and normally translates to actual use (Peter et al., 2008). Satisfaction can be defined as an individual’s perception of the extent to which their needs goals and desires have been sufficiently met (Sanchez-Franco, 2009). With respect to e-learning, satisfaction refers to a user’s overall view of the experience (Wang and Wang, 2009). Whereas intention to use can be defined as the likelihood that an individual will use a software application, in this case, e-learning platforms. The role of intention is critical when it comes to the actual adoption and use of new technology (Davis, 1989). We can also view the intention perspective as an attitude DeLone & McLean, 2003).

Having considered the above factors, we can come up with an all encompassing quality framework that attempts to weave the different parameters together in an attempt to reach a more holistic evaluation on the effect of quality and usability in e-learning.

Proposed framework to be used to assess the impact of Quality and Usability perception on actual uptake of E-learning.

**Figure 5: A framework showing how internal and external quality influences usability**

In coming up with this framework, we consider the processes involved in the development of e-learning. The diagram, figure 5 considers three perspectives and how they are intricately related.

These perspectives include:

- Internal quality-refers to the programmatic make up. (Static Code properties).
- External quality-refers to how the software behaves when it is executed.
- Usability-the extent and ease to which the application meets the users need while in use

To measure internal quality, we can perform tests on static measures of the code, to test quality externally; we can measure the behavior of the product while in use. Usability is then measured based on the end users perspective on how adequate the software was in fulfilling set requirements of use.

There are measures taken at all three levels because internal quality influences external quality, which in turn influences usability, which is dependent on external factors, which are dependent on internal factors.

**CONCLUSION**

The term quality with reference to e-learning is very complex, as we have seen that we have to consider and bring to agreement, many aspects, requirements as well as the perspectives of various stakeholders. To achieve a high quality product in the e-learning (education and training) context, both the learning process and the technology/innovation must be considered.

When a product is of high quality, it addresses all the issues around its use (usability) and as a result it is easy or practical to use and gives the overall feeling of user comfort and satisfaction. To best achieve
this, it is best to develop products based on the users view of quality. Usability must be the key criteria in product development and a key to achieving this is adhering to the criteria for external quality measures that are dependent on adherence to the internal quality measures. The measurement of internal and external quality to examine its effect on usability will help systems designers to make necessary alterations and or adjustments to design content and features to improve quality from the users point of view. Perceptions on usability in turn influence satisfaction and intent to use and these two factors have a direct bearing on actual use this therefore, necessitates the development of an e-learning quality framework that considers all these aspects. This will also help educators, educational administrators and policy makers to inform the decision-making processes with regards to e-learning related investment.

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