# An Intelligent Water Droplet-based Evaluation of Health Oriented Distance Learning

Koffka Khan
The University of the West Indies, Department of Computing and Information Technology, St. Augustine Campus @ TRINIDAD
Email: koffka.khan@sta.uwi.edu

Zulaika Ali, Nisa Philip, Gail Deane and Ashok Sahai
The University of the West Indies, School of Medicine and Dentistry, St. Augustine Campus @ TRINIDAD
Email: { zulaika.ali@sta.uwi.edu, gail.deane@sta.uwi.edu, nisa.philip@sta.uwi.edu, ashok.sahai@sta.uwi.edu}

***Abstract*— An intelligent water droplet-based evaluation of health oriented distance learning of health oriented distance learning (HODL) systems integrating e-learning, e-health and usability aspects of Personal Health Record (PHR) systems is proposed. It supports HODL information processing towards a more comprehensive goal. For measuring HODL usability a checklist is used. Usability dimensions and checklist items are selected using an intelligent water droplet-based computational intelligence model. The main advantage of the methodology is the selection of most critical usability dimensions and items and thus supporting user-oriented design of HODL systems.**

***Index Terms*— health, e-learning, e-health, usability, information systems, evaluation and design, intelligent water droplets**

## I. Introduction

Three factors are converging to motivate a more patient-centered approach to health information. Near universal penetration of information technology in homes and work places, strong demands by some patients to have access to their own health information to participate with health care professionals in health care decision making and management, a trend toward an even larger group of consumers and patients to be active participants in decisions about their health and health care and spiraling health care costs are driving development of Personal Health Record (PHR) systems. PHRs generally include information and communication resources specific to an individual's health and health care. PHRs are gaining widespread attention as they take electronic form and potentially link to medical health records. The complexity of health concepts and terminology and the large number and variety of health conditions makes using PHRs challenging for consumers and, especially so, for those with little computer skill and who have health conditions that limit electronic interactions. As PHRs [2] are disseminated more widely, characteristics of the PHRs themselves may propel consumers and patients toward those that are more user-oriented. The adoption and effectiveness of PHRs will depend as much on systems and user interfaces as on the data in the records.

Usability is crucial to adoption and effective use of all types of information technology innovations, especially in Internet-based applications where help is not available and where many alternatives are a click away. This project aimed to develop an evidence-based framework for usability guidelines. The focus was on grounding the guideline framework in consumer needs assessments and in adding to the usability evidence for the important function of viewing and understanding information displayed in a PHR. The following takes a look at the dimensions of E-learning, E-health and Usability in order to create a check list that can be use assess health oriented distance learning CD courses in an effort to develop better PHRs for patient-centered usage.

Ad hoc design based on intuition and limited experience is not enough to insure the usability of a software application [15]. The literature offers many principles for good interface design. These principles can be helpful guidelines for designers. However, even if every designer in a software development organization was well versed in these design principles, this would not be enough to ensure good interface design. Many of the available design principles are based on experts' intuitions, rather than on hard data.

Usually for any given design problem, they will come in direct conflict with each other, and there am no algorithms for making the tradeoffs. Design principles only bring the designer's attention to the issues which should be considered. There is no "cookbook" approach to applying these principles to ensure good interface design.

User interface design is a matter of compromise ad tradeoff. We want powerful functionality, but a simple, clear interface. We want ease of use but also ease of learning. We want a system that is flexible but also one that provides good error handling. We strive for consistency across all aspects of the interface, but also to optimize individual operations. We want an "intelligent" and sophisticated interface, but also good performance and low cost. The interface designer finds him or herself


doi:10.4304/jait.4.2.91-100

constantly confronted with these kinds of conflicting goals.

Software designers and developers need an overall process to help them effectively structure the design of the user interface, and make good design decisions for a given product with its particular set of end users. The cost effectiveness of applying usability techniques is well documented [34]. The purpose of this tutorial is to present and discuss such a process within the overall context of a typical modem software development life cycle. Practice - rather than theory - is the main focus of this tutorial. Topics presented include requirements analysis, design and testing techniques which can be applied at different points in the development process, as well as organizational medical ad managerial strategies. Specific topics include:

- User Profile
- Contextual Task Analysis
- Usability Goal Setting
- Platform Capabilities/Constraints
- General Design Principles
- Workflow Reengineering
- Conceptual Model Design
- Conceptual Model Mockups
- Iterative Conceptual Model Testing
- Screen Design Standards
- Screen Design Standards Prototyping
- Iterative Screen Design Standards Testing
- Style Guide
- Detailed User Interface Design
- Iterative Detailed User Interface Design Testing
- User Feedback

Detailed instructions on how to carry out each of the usability engineering techniques presented are not offend (most techniques could be the sole topic of a l-3 day tutorial), although brief overviews of each are provided during the tutorial, and supporting materials for many ate included in the Appendix to the tutorial notes. Instead the tutorial describes what techniques are available, and when and why to apply them in the context of the overall software engineering lifecycle. The main focus is on traditional software development, but how to adapt each technique to Web design is also addressed [35].

### A. E-learning

E – Learning [4], [5], [16], [18], [20], [21] can be defined as the use of information technologies to enhance knowledge and performance. E-learning is also called Web-based learning, online learning, distributed learning, computer-assisted instruction, or Internet-based learning. Historically, there have been two common e-learning modes: distance learning and computer-assisted instruction. Distance learning uses information technologies to deliver instruction to learners who are at remote locations from a central site. Computer-assisted instruction (also called computer-based learning and computer-based training) uses computers to aid in the delivery of stand-alone multimedia packages for learning and teaching. These two modes are subsumed under e-learning as the Internet becomes the integrating technology.

Research [4], [27], [32] suggests that an eventual information technology success will depend both on its adoption and subsequent continued usage. The following are some critical dimensions that have define e-learning. The critical dimensions of e-learning:

- Quality of Courses: This covers information quality, whether information provided is accurate, up to date and relevant to the overall theme of the course. System quality, which is concern with whether there are any bugs in the system, the consistency of the user interface, ease of use, response rates in interactive systems, quality documentation. An increasingly important component is service quality, which is derive from the comparison between what the customer feel should be offered and what actually provided.
- Relevancy of content: Content comprises all instructional material, which can range in complexity from discrete items to larger instructional modules. A digital learning object is defined as any grouping of digital materials structured in a meaningful way and tied to an educational objective. Learning objects represent discrete, self-contained units of instructional material assembled and reassembled around specific learning objectives, which are used to build larger educational materials such as lessons, modules, or complete courses to meet the requirements of a specified curriculum. Each unit must relate to the course.
- Comfort level with technology: technology literacy of the user.
- Availability of technical support:
- Usability: the extent to which a product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context.
- Standards: standards are increasingly playing an important role in the creation of new e-learning material. Such standards are accepted principles that promote compatibility and usability of products accross many computer systems to facilitate a wide spread use of e-learning material.

### B. E-health

E-health [19], [13], [10], [17] is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.

With reference to diverse medical education contexts, e-learning appears to be at least as effective as traditional instructor-led methods such as lectures. Health care providers do not see e-learning as replacing traditional instructor-led training but as a complement to it, forming part of a blended-learning strategy. A developing infrastructure to support e-learning within medical education includes repositories, or digital libraries, to manage access to e-learning materials, consensus on technical standardization, and methods for peer review of these resources. E-learning presents numerous research opportunities for faculty, along with continuing challenges for documenting scholarship. Innovations in e-learning technologies point toward a revolution in education, allowing learning to be individualized (adaptive learning), enhancing learners' interactions with others (collaborative learning), and transforming the role of the teacher. The integration of e-learning into medical education can catalyze the shift toward applying adult learning theory, where educators will no longer serve mainly as the distributors of content, but will become more involved as facilitators of learning and assessors of competency. Key dimension of E health are:

- Relevant content: The content must be applicable to the users. Content will therefore comprise of all instructional material which can range in complexity. Each unit having specific learning objective that adds to the overall requirements of a specified curriculum.
- Availability: the ability to access repositories of information.
- Delivery: Content delivery can either be real time where all learners receive information simultaneously and communicate directly with other learners. (Teleconferencing internet chat IM. Also delivery can be asynchronous where the learners are responsible for pacing their own self instruction and learning. ( cds, online bulletin boards, web blogs).
- Quality: information quality as it relates to timeliness, relevance, and accuracy of information, documentation.
- Content usability: The ability to use, apply or translate what is learnt into the persons every day functions.
- Demonstration of learning: changes in learner knowledge, skills or attitudes.
- Peer- review: an examination, verification and validation of content and process by peers.
- Continuing intention: The desire, drive for continuing medical education.
- Standards: Universal accepted principles that promote compatibility and usability of products across many computer systems to facilitate a wide spread use of e-learning material.

### C. Usability

Usability [9] can be defined as the extent to which an application is learnable and allows the user to accomplish specified goals efficiently, effectively and with a high degree of satisfaction. In healthcare, clinicians manage sensitive and complex information while working in a highly agile work environment. A critical prerequisite for computer systems to be successfully implemented in such settings is that their interactive user interfaces are streamlined to the working practices of their users and are highly usable [11]. To verify and optimize system usability, a variety of analytical and empirical methods from the area of usability engineering and human-computer-interaction have been adapted to and applied in healthcare system evaluation studies [26], [2].

It is argued that applying these methodologies to healthcare information systems design and evaluation will lead to an understanding of clinicians' reasoning and processing of health care concepts crucial in system re-design efforts [19]. The diversity in usability methods and type of health care system to which these methodologies have been applied has made it difficult to gain a clear overview on what insights on healthcare systems development have been acquired and where challenges for future usability studies remain. A detailed investigation of published usability studies may reveal the benefits and trade-offs of usability methods applied in the healthcare environment and give insight into how information needs of targeted health care users may or may not be reached. An additional component that should be added to this definition is usefulness: that is a highly usable application will not be embraced by users if it fails to contain certain content that is relevant and meaning full. Some usability dimensions are:

- Learnability: In the informing environment. The delivery system creates clients learning in a short amount of time leading to easily accomplished task.
- Memorability: The delivery system causes the learner to remember how to use the system without reiterating the learning cycle.
- Operability: the learner is able to operate/ navigate and control the delivery system with ease.
- Flexibility: The delivery system is fully adaptable to variation and changes in tasks within the informing environment. It allows the learner to become accustomed to changes that are given in various tasks.
- Understandability: The learner easily understands the aptness of the delivery system in accomplishing a given task within the informing environment.
- Reliability: The delivery system is reliable and dependent enough for the client to accomplish tasks.
- Attractiveness: is the ability of the delivery system to attract and draw client attention within the informing environment. It also addresses the aesthetic satisfaction that the delivery system provides the client within the informing environment
- Effectiveness: The delivery system is effective is if the learner completely accomplishes a given task with accuracy and precision within the informing environment
- Efficiency: the learner becomes efficient in using the delivery system if he or she has gained adequate skills and ability to perform a given task within the informing environment.
- Attitude & Satisfaction: A & S attributes refer to the degree of the client approval. Pleasure, happiness, fulfillment, contentment agreement. Liking, comfort, appreciation, and enjoyment of /with the delivery system within the informing environment.

## II. Intelligent Water Droplets Methof for Health Oriented Distance Learning

### A. Methodology

A methodology for HODL system evaluation and usability redesign is developed (cf. Figure 1). It includes a checklist (cf. section D) and a model (cf. Figure 1) for HODL system assessment. At steps 1 and 2 the checklist dimensions and items are determined [33]. At step 3 data is gathered by interviews, observations and measurements. At step 4, HODL system is evaluated and a quantitative HODL index is determined using the data gathered. Based on evaluation relevant corrective measures for improving HODL systems (step 5 & 6) are proposed and implemented (step 7 & 8).

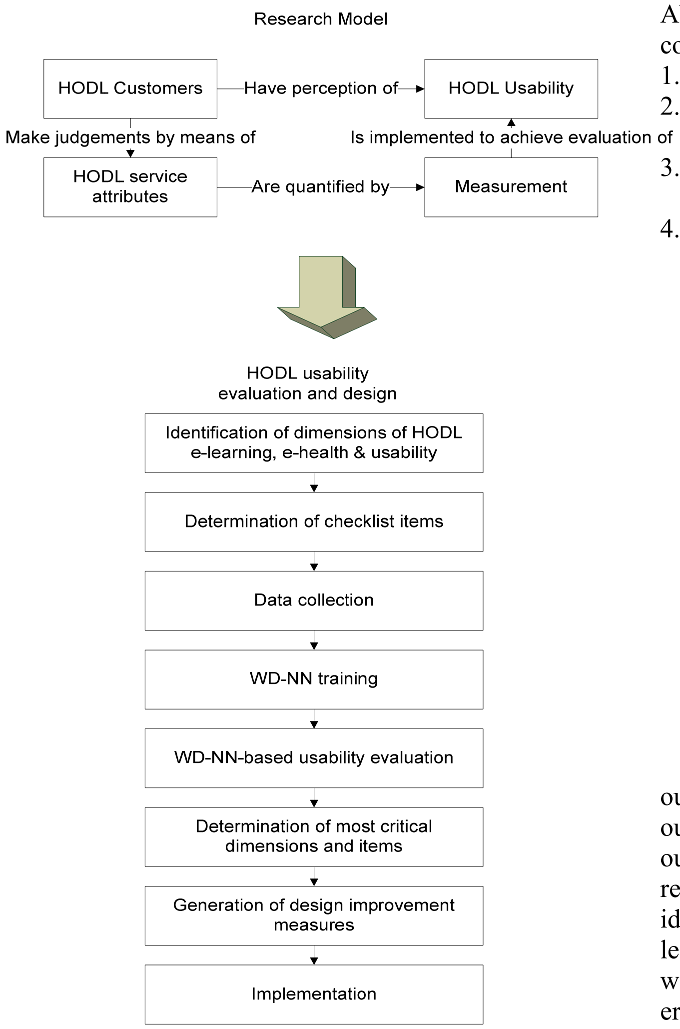


Figure 1: WD-NN-based method for HODL usability evaluation and design

### B. Artificial Neural Networks

Artificial Neural Networks (ANN) (cf. Figure 2) consist of a parallel collection of simple processing units (neurons/nodes) arranged and interconnected in a network topology [31], [22], [30]. ANN inspired by biological nervous system, are known as parallel distributed processing (PDP) systems. ANN consists of a set of interconnected processing units (node, neurons or cells). Each node has activation functions. The activation signal sent (output) by each node to other nodes travel through weighted connection and each of these nodes accumulates the inputs it receives, producing an output according to an internal activation function. ANN is closely related to its architecture and weights. Multilayer architecture of network can be used to solve both classification and function approximation problems. There are two types of learning networks which are supervised learning and unsupervised or self-organizing. Supervised learning is when the input and desired output are provided while for unsupervised learning, only input data is provided to the network.

The most popular supervised learning technique in ANN is the back propagation (BP) algorithm. Its learning consists of the following steps:

1. An input vector is presented at the input layer.
2. A set of desired output is presented at the output layer.
3. After a forward pass is done, the errors between the desired and actual output are compared.
4. The comparison results are used to determine weight changes (backwards) according to the learning rules.

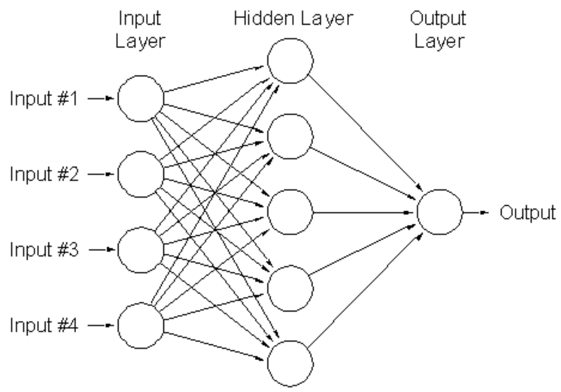


Figure 2: Artificial Neural Network (ANN)

In order to get the desired output from ANN, the output from the network is compared to actual desired output. During training, the network tries to match the outputs with the desired target values. Network need to review the connection weight to get the best output. The idea of the BP is to reduce this error, until the ANN learns the training data. The training begins with random weights, and the goal is to adjust them so that the learning error will be at minimal. ANN nodes in BP algorithm are organized in layers, send their signals forward and then the learning error (difference between actual and expected results) is calculated and propagated backwards until met satisfactory learning error.

### C. Intelligent Water Droplets (IWD)

Intelligent Water Drops algorithm (IWD) [24] is a swarm-based nature-inspired optimization algorithm, which has been inspired from natural rivers and how they find almost optimal path to their destination. A natural river often finds good paths among lots of possible paths in its ways from the source to destination. These near optimal or optimal paths follow from actions and reactions occurring among the water drops and the water drops with their riverbeds. In the IWD algorithm, several artificial water drops cooperate to change their environment in such a way that the optimal path is revealed as the one with the lowest soil on its links. The solutions are incrementally constructed by the IWD algorithm. Consequently, the IWD algorithm is generally a constructive population-based optimization algorithm. The Intelligent Water Drop, IWD for short, flows in its environment has two important properties:

1. The amount of the soil it carries now, Soil (IWD).
2. The velocity that it is moving now, Velocity (IWD).

This environment depends on the problem at hand. In an environment, there are usually lots of paths from a given source to a desired destination, which the position of the destination may be known or unknown. If we know the position of the destination, the goal is to find the best (often the shortest) path from the source to the destination. In some cases, in which the destination is unknown, the goal is to find the optimum destination in terms of cost or any suitable measure for the problem.

We consider an IWD moving in discrete finite-length steps. From its current location to its next location, the IWD velocity is increased by the amount nonlinearly proportional to the inverse of the soil between the two locations. Moreover, the IWDs soil is increased by removing some soil of the path joining the two locations. The amount of soil added to the IWD is inversely (and nonlinearly) proportional to the time needed for the IWD to pass from its current location to the next location. This duration of time is calculated by the simple laws of physics for linear motion.

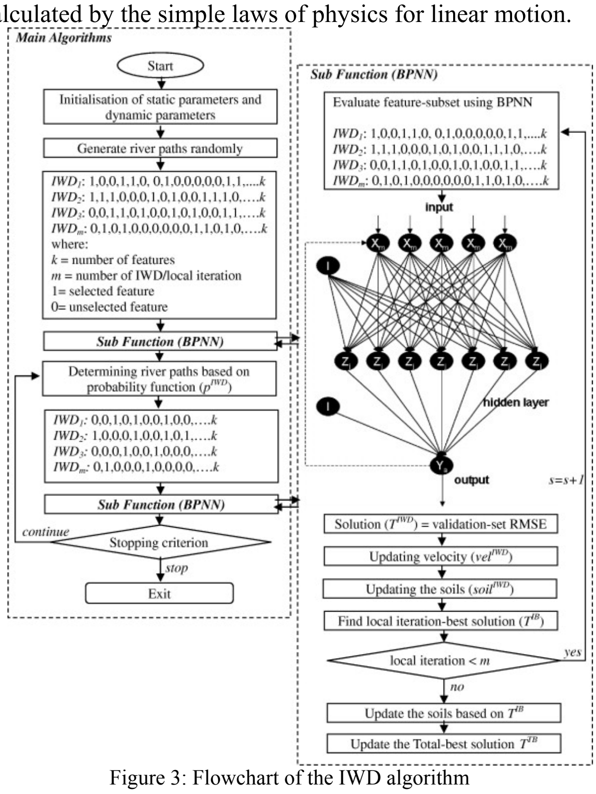


Figure 3: Flowchart of the IWD algorithm

Thus, the time taken is proportional to the velocity of the IWD and inversely proportional to the distance between the two locations. Another mechanism that exists in the behavior of an IWD is that it prefers the paths with low soils on its beds to the paths with higher soils on its beds. To implement this behavior of path choosing, we use a uniform random distribution among the soils of the available paths such that the probability of the next path to choose is inversely proportional to the soils of the available paths. The lower the soil of the path, the more chance it has for being selected by the IWD.The IWD algorithm gets a representation of the problem in the form of a graph (N, E) with the node set N and edge set E. Then, each IWD begins constructing its solution gradually by traveling on the nodes of the graph along the edges of the graph until the IWD finally completes its solution. One iteration of the algorithm is complete when all IWDs have completed their solutions. After each iteration, the $\text{iteration}_{best}$ solution $T^{IB}$ is found and it is used to update the $\text{total}_{best}$ solution $T^{TB}$. The amount of soil on the edges of the iteration-best solution $T^{IB}$ is reduced based on the goodness (quality) of the solution. Then, the algorithm begins iteration with new IWDs but with the same soils on the paths of the graph and the whole process is repeated. The algorithm stops when it reaches the maximum number of iterations $\text{iter}_{max}$ or the total-best solution $T^{TB}$ reaches the expected quality. The IWD algorithm has two kinds of parameters. One kind is those that remain constant during the lifetime of the algorithm and they are called 'static parameters'. The other kind is those parameters of the algorithm, which are dynamic and they are reinitialized after each iteration of the algorithm.

The algorithm of IWD is specified in the following steps, cf. Figure 3. Note that IWD is used as the neural network backpropagation training and learning algorithm hence the terminology used in the diagram is BPNN, backpropagation neural network. For further information on the algorithm readers are referred to [24].

### D. Health Oriented Distance Learning Checklist

There are both unique and overlapping segments in the fields of HODL Usability, and HODL Quality. Figure 4 presents the areas that are of primary concern to this paper (12, 123 and 23).

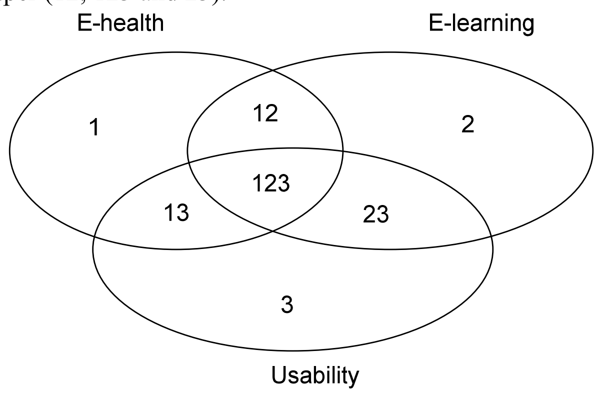


Figure 4: Overlapping field segments

For defining *HODL e-learning, e-health and usability dimensions* many scales were investigated and pertinent ones selected. Their dimensions and questions were compared and contrasted to produce HODL scales covering the three fields. The new HODL usability scale consists of ten dimensions as presented in Figure 3 and was constructed on the basis of analyses of the data from three studies done with different checklists. It is implemented as a new checklist with eleven HODL dimensions and 53 respective questions measured as the extent to which participants agreed with statements on five-point Likert scales, ranging from "Strongly Disagree" to "Strongly Agree."

The initial selection of items from these checklists was based on factor loadings, relevance according to a group of experts in oncology, and the distribution of answers. Items with excessively skewed distributions were excluded. This yielded a 53-item list.

*Dimension 1 – Accessibility*

- I found that the lesson was free from technical problems (link errors, problems viewing sections etc.).
- I found that the lesson appeared quickly on the screen.

*Dimension 2 - Feedback*

- I found that the feedback to my incorrect answers was useful.

*Dimension 3 – Navigation*

- I found that links actually lead to the content they promised.
- I always knew where I was in the lesson.

*Dimension 4 – Relevancy*

- I found that the information was up to date.
- The information presented was relevant to what I was supposed to learn.

*Dimension 5 – Perspicacity*

- Using the lesson improved my learning performance.
- The lesson simplified my learning process.

*Dimension 6 – Learning style*

- When a concept was taught or illustrated in more than one way, it helped me understand it.
- I quickly recognized the key points presented throughout the lesson.

*Dimension 7 – Learnability*

- The material was at an appropriate level for me.
- I found that the information was easy to understand.

*Dimension 8 – Content*

- Abstract concepts (principles, formulas, rules, etc.) that were illustrated with concrete, specific examples helped improve my understanding.
- I found that the information was concise and right to the point.

*Dimension 9 – Appropriate learner control*

- I felt in control throughout the lesson.

*Dimension 10 – Motivation to learn*

- The lesson was enjoyable and interesting.
- The lesson provided me with frequent and varied learning activities that increased my learning success.

In *HODL WD-NN usability evaluation model* the entire construct of usability is represented by a single dependent variable. Two different quantitative indices are calculated for the usability evaluation of HODL systems, as shown in Figure 5.

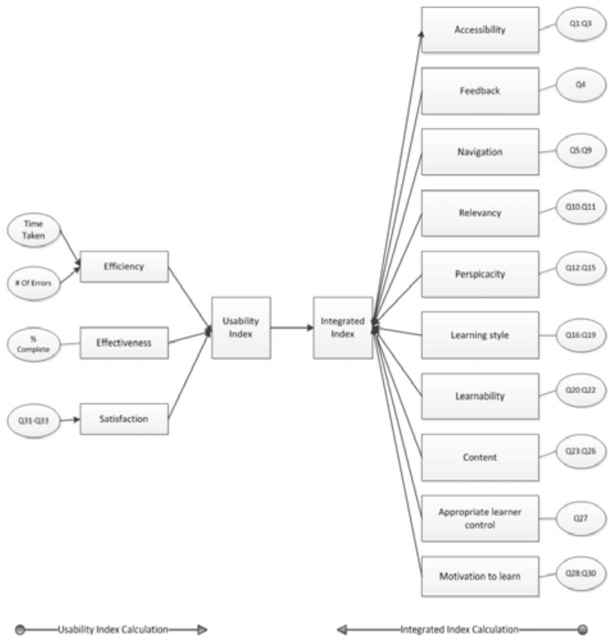


Figure 5: HODL WD-NN usability evaluation model

The *usability index* was calculated using the efficiency, effectiveness and satisfaction dimensions. Both objective and subjective measures of HODL usability are gathered. The objective data (efficiency and effectiveness) are measured as follows. For each task, HODL *efficiency* was measured using [9]:

1. Time taken to perform a task:
2. Number of errors made while performing the task

For each task, HODL *effectiveness* is measured using the percentage of the task solved. *Satisfaction* was measured by customer's subjective response to a question.

The weights of the dimensions of usability index efficiency, effectiveness and satisfaction are determined by principal component analysis.

The *integrated index* uses ten e-learning, e-health and usability dimensions. The most critical usability dimensions / checklist items are adaptively determined by the weights of neural network. Depending on the problems that these dimensions/questions indicate relevant design improvements of HODL system are proposed.

## III. Case Study

For experimental implementation and study of WD-NN method a HIV e-learning tool was used. 150 medical health students and workers at the University of the West Indies participated in the study. Students were divided into two groups. Year four and five students were the largest test group and this was useful for testing purposes, because they represented the most inexperienced computer users. The students read the course material and answered an online survey with questions pertaining to what they had read. The following were the instructions given to the groups.

TABLE 1.

TASK LIST FOR HODL GROUP ONE

| Group 1 |
|---|
| Load CD-ROM in computer |
| Play CD-ROM |
| Go to Module 2 |
| Perform the follow tasks in Module 2:<br>1. Read pages 1 – 16<br>2. Navigate to all hyperlinks<br>– Pop-ups<br>– Glossary<br>– PDFs<br>3. Take quiz<br>4. Enter quiz score on questionnaire<br>5. Return to main menu<br>6. Quit CD-ROM |

TABLE 2.

TASK LIST FOR HODL GROUP TWO

| Group 2 |
|---|
| Load CD-ROM in computer |
| Play CD-ROM |
| Go to Module 4 |
| Perform the follow tasks in Module 4:<br>1. Read pages 1 – 16<br>2. Navigate to all hyperlinks<br>– Pop-ups<br>– Glossary<br>– PDFs<br>3. Take quiz<br>4. Enter quiz score on questionnaire<br>5. Return to main menu<br>6. Quit CD-ROM |

The following screenshots shows parts of a HODL course module (cf. Figure 6, 7, 8).

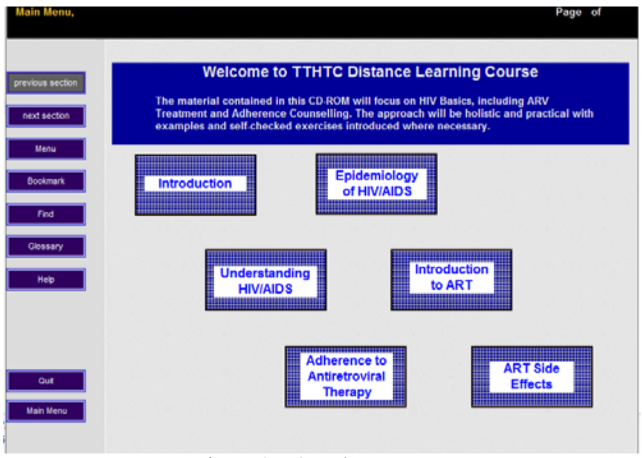


Figure 6: HODL homepage

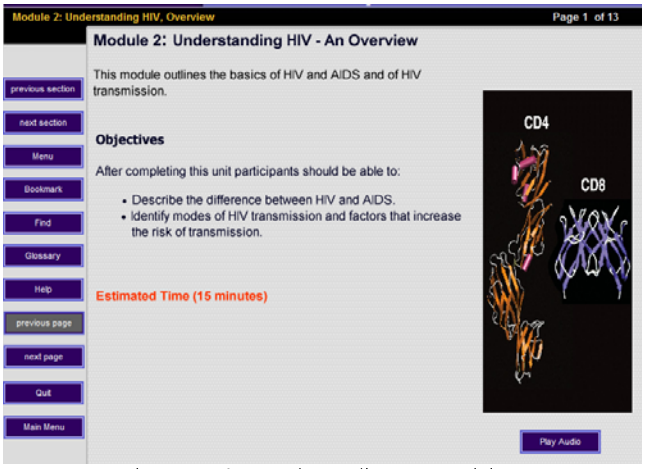


Figure 7: HODL understanding HIV module

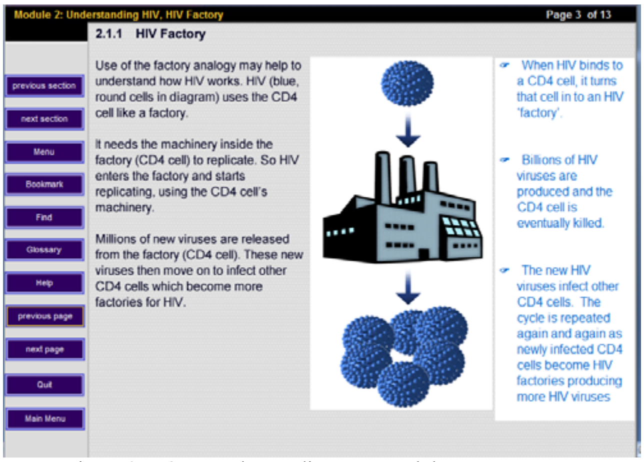


Figure 8: HODL understanding HIV module content page

For each of these three questions is recorded the time, number of errors for performing the task and the percentage of tasks solved. The time taken to complete the tasks and checklist was on average 70-90 minutes per student. By principal component analysis the weights of the dimensions of usability index efficiency, effectiveness and satisfaction were found as 0.26, 0.34 and 0.40 respectively.

We ran a neural network (WD-NN) of two layers with 10 neurons at hidden layer using MATLAB software.

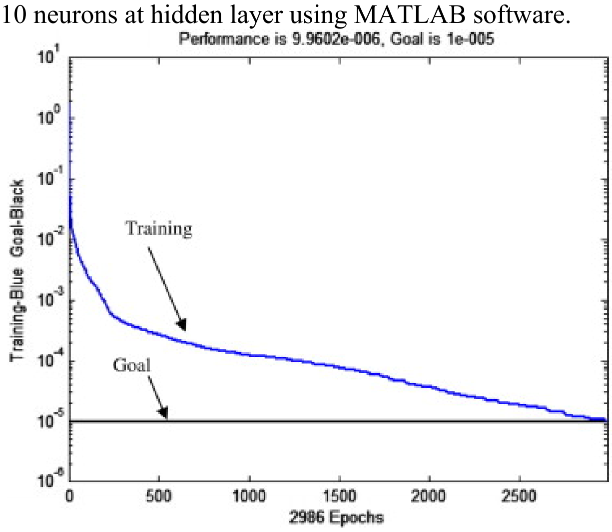


Figure 9: WD-NN training performance for (N=12) data set

The inputs were the user response values of the 33 checklist questions and the output was the usability index. An intelligent water droplet optimization backpropagation was used for network training. The resulting network weights were used to define the critical HODL usability dimensions and respective questions. We randomly assigned one fourth of the data (38 observations) as testing data set and three fourth (112 observations) as training data set (cf. Figure 9, 10).

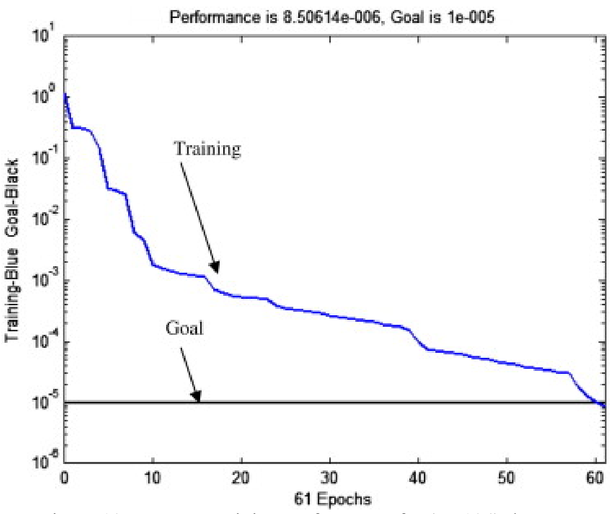


Figure 10: WD-NN training performance for (N=104) data set

The most critical dimensions affecting HODL usability and their percentage of integrated usability index were: navigation (16%), appropriate learner control (14%), learning style (10%) and accessibility (9%).

Then we determined the most critical subdimensions (checklist questions):

Q8. I found that it was easy for me to find what I wanted and get on with what I needed to do.

Q27. I felt in control throughout the lesson.

Q19. I quickly recognized the key points presented throughout the lesson.

Q1. I could find what I needed.

Taking into account the above results and the participants comments we proposed improvements of HODL system, e.g.

- A lesson summary could have been placed on the homepage. This would enable the viewers to immediately see the course contents for to the lesson.
- Using mouseovers in parts of the lessons where the text color alone did not clearly indicate that there were hidden underlying behaviors, for example, a pop-up explaining the text.

## IV. DISCUSSION

Many authors advocate that collaborative pedagogies create a framework for meaningful learning and that the online environment supports as much construction and sharing of knowledge as traditional classroom group activities. It has also been suggested that online discussions enable more reflection by students than in face-to-face interaction [28], [7].

Others however question these assertions, suggesting that online interaction may not be as meaningful and sociable as the more traditional methods [23], [25]. The purpose of this study was not to evaluate the value of online collaborative learning versus classroom collaborative learning, but rather to evaluate whether the introduction of collaborative activities in a HODL enhanced the experience of students and medical practitioners on a distance-learning course. Whilst a HIV course was selected, it is felt that the issues raised here would have resonance in other health care education scenarios.

As a pre-session to the first activity students were encouraged to form an online identity and to get to know other students in their group before learning took place. [3] is an advocate of early socialization and how online environments offer great opportunities for networking. However she also emphasizes the importance of active intervention of the tutor in this process along with a thoughtful approach to the design of systems similar to the HODL. As in face-to-face environments, students are more likely to interact with their peers if they trust and have mutual respect for others in their group. The tutor plays a very important role in developing these qualities and ensuring that students are motivated to socialize.

The second activity involved students within this group using discussion boards and live chat rooms to investigate the learning outcomes of the module. Eighty nine percent of students participated in this task. Most groups used the discussion boards but two groups also collaborated synchronously in the live chat rooms. The task revealed that many students misunderstood the meaning of key words in the learning outcomes. The tutor was able to rectify these misunderstandings and redirect the discussions on a more appropriate course. The discussions were very active, with over 140 answers being made during this activity.

Some students were more dominant than others in that they answered very detailed and lengthy posts whereas others said less. However the lengthier posts were often quite vague and tended to wander off topic. The tutor was able to intervene when this happened and reiterate the importance of being concise. The feedback from this activity via the University modular assessment questionnaire was very good. There were some criticisms, in particular the additional time pressures it placed on students and the difficulty of getting a discussion going. Interestingly group leaders recognized the fact that despite these problems, useful discussions had taken place and these had been educationally meaningful.

The third activity involved students from both groups working in the same groups to produce questions with outline answers for the module assessment. Although most of the questions supplied were on topics relevant to the module content, the contributions made by all students revealed that they had not fully grasped the requirements of HIV learning as they produced questions that could not be answered to the required depth in the word limit. Most responses were mainly descriptive rather than analytical and there were some factual errors.

However this activity provided the tutor with an opportunity to formatively feedback to students at an early stage enabling them to address these shortcomings in time for a final worksheet.

It was evident that some students recognized the wide variety of experience and expertise within their group. They appreciated that this experience may be different from their own and that group discussion, particularly around the selection of questions and outline answers, could inform their own learning in a positive way. [29] contends that group diversity in terms of knowledge and experience contributes positively to the learning process. Collaborative learning strategies particularly improve problem solving because the students are confronted with different interpretations of the problem [6]. One group was particularly active in critical analysis of their group's contributions. The tutor encouraged this by asking these students to give reasons for their comments and reflect upon the criteria used in making these judgments. Generally, peer critiquing worked well in this group with one student commenting that the ability to admit that the outline answer he submitted was flawed helped him reassess his understanding of the module content.

## V. CONCLUSIONS

A method for adaptive usability evaluation of HODL systems WD-NN was proposed. It includes a checklist and a neural networks-based model for evaluation of HODL usability. A case study confirmed WD-NN applicability for measuring and allocation of usability problems. The advantages of the approach are: (1) measuring by WD-NN checklist of e-learning, e-health and usability of HODL systems; (2) adaptive selection of most significant usability dimensions and items and thus significant reduction of the time for usability evaluation and design.

The implementation of three online collaborative initiatives into the delivery of the Scientific Principles of HIV module has enhanced student socialization and has enabled students to work together to understand the learning outcomes and to learn from each other in the development of an assessment. In addition the University Modular assessment questionnaire showed that students valued these activities and improved their experience of distance learning. However some students commented on the time taken to complete these tasks and felt that they detracted from rather than added to their learning. This indicates that the tasks may need to be modified in future so that they take less time to complete without affecting their educational value.

The implementation of similar online collaborative activities may therefore be justified in other learning environments, both distance and blended. There is a huge variety in the types of tasks that could be used in the online collaborative environment including those with theoretical, clinical and educational foci. Health care educationalists should therefore consider this pedagogy [14]. However there are some important considerations. Tutors involved in e-learning must be supported and provided with training. For example, the tutor spent a significant amount of time moderating discussions and providing feedback and this could have been done in a more efficient way. [29] stresses that different types of collaborative exercises warrant a different approach to moderation and feedback. Tutors need a different skill set to more traditional teaching methods and therefore specific training with support from e-learning experts is usually required [1]. In addition the unconstrained nature of e-learning where there may be no clear start and finish times can pose time management problems. Tutors must ensure that this is anticipated and planned for.

There is great scope for further research in this area. Issues such as group composition and size, differences in collaborative learning styles associated with ethnicity and gender and the optimum strategies for managing and moderating online collaborative activities all merit further investigation.

## REFERENCES

[1] Aad, G., et al. "Observation of a New [subscript χb] State in Radiative Transitions to Y (1S) and Y (2S) at ATLAS." (2012).
[2] Ash J, Coiera A, Berg M. Some unintended consequences of information technology in healthcare: the nature of patient care information systems. J Am Med Inform Assoc
[3] Benson, Robyn, and Gayani Samarawickrema. "Teaching in context: Some implications for e-learning design." ICT: providing choices for learners and learning. ASCILITE, 2012.
[4] De Villiers Ruth. Usability of an E-Learning Tutorial: Criteria, Questions and Case Stud. AICSIT; 75, 2004.
[5] Ehlers, Ulf-D. "Quality in e-learning from a learner's perspective." Learning, 2012.
[6] Ellingson, J. M., et al. "Disentangling the relationships between maternal smoking during pregnancy and co-occurring risk factors." Psychological medicine 42(7): 1547, 2012.
[7] Gallivan, Michael J. "THE VALUE OF SOCIAL MEDIA FUNCTIONALITY IN "DESIRE2LEARN"." 2012.
[8] Grandon, T,G. & Cohen, E. (eds), 5: 113-134, 2003.
[9] ISO 9241-11, Guidance on usability, 1998.
[10] Kennedy, Catriona M., et al. "Active Assistance Technology for Health-Related Behavior Change: An Interdisciplinary Review." Journal of Medical Internet Research 14(3): 2012.
[11] Koohang, A. Expanding the concept of usability. Foundations of informing science: 1999-2008
[12] Kushniruk AW, Triola MM, Borycki EM, Stein B, Kannry JL. Technology induced error and usability: The relationship between usability problems and prescription errors when using a handheld application. Int J Med Inform
[13] Mair, Frances S., et al. "Factors that promote or inhibit the implementation of e-health systems: an explanatory systematic review." Bulletin of the World Health Organization 90(5): 357-364, 2012.
[14] Marra, Fabio, et al. "Amikacin Reverse Iontophoresis: Optimization of in Vitro Extraction." International Journal of Pharmaceutics, 2012.
[15] Mayhew, Deborah J.. Principles and Guidelines in
[16] Michael J.M. Usability in E-learning, website file: Learning circuits, http://www.neiu.edu/~sdundis/textresources/Usability/Usability%20in%20E-Learning.pdf, 2005.

[17] Morrison, Leanne G., et al. "What design features are used in effective e-health interventions? A review using techniques from critical interpretive synthesis." Telemedicine and e-Health 18(2): 137-144, 2012.
[18] Nawaz, Allah. "Metaphorical Interpretation of eLearning in Higher Education Institutions." Journal of Advances in Information Technology 3(1): 1-9, 2012.
[19] Patel, L.V., Kuskniruk, W.A. Interface design for health care environments: the role of cognitive science, Proc. AMIA Symp (1998), 29-37.
[20] Peterson D. What makes a good learning Website? The concept and measurement of usability in e-learning. http://www.tim-brosnan.net
[21] Raitman, Ruth S. Collaboration in the online e-learning environment. No. Ph. D.. Deakin University, 2012.
[22] Rassam, Murad Abdo, and Mohd Aizaini Maarof. "Artificial Immune Network Clustering approach for Anomaly Intrusion Detection." Journal of Advances in Information Technology 3(3): 147-154, 2012.
[23] Ravenscroft, Adrian C., and Stephen J. Kleshinski. "Removeable embolus blood clot filter and filter delivery unit." U.S. Patent No. 8,133,251. 13 Mar. 2012.
[24] Rayapudi, R.S. An Intelligent Water Drop Algorithm for Solving Economic Load Dispatch Problem, International Journal of Electrical and Electronics Engineering 5:1, 2011. Software User Interface Design, Prentice-Hall, 1992
[25] Stacey, Elizabeth. "Learning links online: Establishing constructivist and collaborative learning environments." Proceedings of the International Education & Technology Conference: Untangling the web-establishing learning links. ASET, 2012.
[26] Tang C.P., Patel, V.L. Major issues in user interface design for health professional workstations: summary and recommendations, Int J Biomed Comput 34(1994), 139-48
[27] Thakurta, P. K., et al. "A New Approach on Cluster based Call Scheduling for Mobile Networks." Journal of Advances in Information Technology 3(3): 184-190, 2012.
[28] Westbrook, Catherine. "Imaging (MRI), Faculty Health, Social Care and Education Department of Allied Health and Medicine, Anglia Ruskin University, United Kingdom."
[29] White, Laura M., et al. "Appraisal of Critical Thinking Skills in Animal Science Undergraduates who Participated on a Nationally Competitive Collegiate Judging Team." NACTA Journal, 2012.
[30] Winters, R. Michael, and Ichiro Fujinaga. "Artificial Neural Networks." 2012.
[31] Yao, X., Evolutionary artificial neural networks. International journal of neural systems, Vol.4, No.3, 1993, 203–222.
[32] Yu, Xiu-qing. "Research on Learning Effect based on Outer P-set." Journal of Advances in Information Technology 3(1): 21-23, 2012.
[33] Zaharias P. Developing a Usability Evaluation Method for E-Learning Applications: From Functional Usability to Motivation to Learn.http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.130.4304.
[34] Bias, Randolph G. and Mayhew, Deborah J., Eds., Cost-Justifying Usability, Academic Press, 1994
[35] Forsythe, Chris, Grose, Eric and Ratner. Julie, Human Factors and Web Development, Lawrence Erlbaum Associates, 1998

**Koffka Khan** was born in San Fernando, Trinidad and Tobago in 1978. He received the B.Sc. and M.Sc. degrees from University of the West Indies, in 2002 and 2008, respectively. He was awarded by the University of the West Indies for his contributions made in postgraduate work in 2009 as a research assistant.

He is working presently at The University of The West Indies; St. Augustine Campus (TRINIDAD & TOBAGO) as a Tutor in Computer Science in the Department of Computing and Information Technology (Faculty of Science & Agriculture) since September 2006. Mr. Khan started his teaching-n-research career as a Demonstrator in Computer Science at the University of The West Indies at the Department of Mathematics and Computer Science. He has up-to-date, published ten research and co-authored four papers in journals of international repute & in the proceedings of international conferences.

**Ashok Sahai** is working presently at The University of The West Indies; St. Augustine Campus (TRINIDAD & TOBAGO) as a Professor of Statistics in the Department of Mathematics & Statistics (Faculty of Science & Agriculture) since February 2006. Dr. Sahai started his teaching-n-research career as a Lecturer in Statistics Department at Lucknow University (INDIA) in July 1966, and continued thereat till April 1980. He has, up-to-date, published more than one hundred research papers in peer-reviewed journals of international repute & in the peer-reviewed proceedings of international conferences.

He worked as Reader in Statistics and as Professor of Statistics in the Department of Mathematics at University of Roorkee (Now IIT Roorkee) during the period: April 1980- July 1995. Prof. Sahai had also worked as an Assoc. Professor of Statistics at University of Dar-Es-Salaam; TANZANIA (East Africa) during the period: July 1982- June 1984, and as a Professor of Statistics at University of Swaziland (Southern Africa) during the period: July 1993- June 2003. He worked as a Guest Scholar @ PharmacoEconomic Research Centre; University of Arizona, TUCSON during the period from July 2003 to October 2003 and as Visiting Professor @ Hyderabad; INDIA during December 2003 to January 2006 in ICFAI Tech. University, Medchel Rd.; in Aurora School of Management at Chikkadpally; and in St. Ann's P.G. (Management) College For Women at Mallapur.