Inducing optimal experience in a moodle environment

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Although distance learning is widely adopted nowadays, the computer Course Management Systems (CMS) dominate the field of Web-based Instructional Systems (WbIS) design and the role of the educational specialist in developing these systems is marginal. Thus, a new tool is needed to enable the educationalists to apply their theories in the field of WbIS design. Indeed, WbIS design needs a common framework that includes all participants in the project. Furthermore, a methodology is needed in order to apply it during course design. This paper investigates the possibility of designing a project using Activity Theory (AT) as a framework infusing constructivist environment and educational theories that could increase the opportunities of optimal user experience. Indeed, usability is concerned with the quality of an interactive computer system with respect to ease of learning, ease of use, and user satisfaction. Thus, the objective is to develop web-based courses that are easy to learn, effective to use and provide an optimal user experience. The study aims at better analysis and design of Web-based Instructional Systems as well as better evaluation of the user experience with these learning environments. It introduces a real case study for an education technology web-based course designed adopting the AT as a framework and implemented using the Moodle CMS. The optimal experience of learners is evaluated and the results are statistically analyzed using the SPSS statistical software package. Several future research directions are suggested that need contribution and further cooperation between computer scientists specially people concerned with Human Computer Interaction (HCI) and Web engineers, as well as, Educational specialists.

مع سيطرة المتخصصين فى مجال الحاسبات وبرمجيات ادارة المقررات CMS على مجال تصميم النظم التعليمية القائمة على الانترنت WbIS وتهميش دور التربوى يتحتم البحث عن آداه فى يد التربوى وأطار مشترك يساعد على وجود أساس نظرى ذى تميز لمجال تفاعل المتعلمين مع الكمبيوتر والانترنت. أى يتحتم البحث عن اطار مشترك للتعاون بين كل من مصممى ومطورى برمجيات أدارة المقررات فى مجال تصميم النظم التعليمية على الانترنت WbIS والتربويين المتخصصين وقد أكدت الدراسات فى مجالات متعددة منها الاتصال بين الانسان والآلة HCI جدوى نظرية النشاط كفكر جديد لتصميم النظم بتقسيمها الى وحدات من أنظمة النشاط Activity Systems حيث الأساس فيها العلاقة بين المتعلم و الموضوع بينما تشير دراسات الخبرة المثلى Optimal Experience إلى ارتباط وجودها بوجود ارتباط قوى بين المتعلم والموضوع أثناء تأدية مهام التعلم فى المقرر فيتسم المقرر المنتج بأنه يرتقى ويزيد من فرص حدوث الخبرة المثلى لدى المشاركين؟ فالخبرة المثلى مهمة لوصف التفاعلات العامة للإنسان مع الكمبيوتر. ولذا فالسؤال محل الدراسة هو: إلى أى مدى يمكن لهذا المشروع المصمم من منطلق إطار عمل "نظرية النشاط" لبيئة بنائية، أو مزيج من البنائية، ونظريات تعلم المعلمين فى مرحلة التطوير المهنى أن يزيد من فرص مرور الطلاب بأجود أنواع الخبرات التعليمية، وهى خبرة التدفق Flow أو ما أسماه "تشك زهنت مى هاى "Csikszentmihalyi" الخبرة المثلى "Optimal Experience"؟ وما نسبة حدوثها؟ ويقدم البحث نتائج دراسة الحالة بعد تصميم المقرر وتجربته فعليا على طلاب كلية التربية كما يقدم الكثير من التوصيات ويفتح الطريق لمزيد من التعاون بين الأطرف المعنية بالبحث فهو نتاج لعمل مشترك بين كليات التربية والهندسة.

Keywords: Activity theory, Computer Supported Cooperative Work (CSCW), E-learning, Human Computer Interaction (HCI), Web-based Instructional Systems (WbIS)

1. Introduction

Teaching educational technology courses in closed rooms without making use of the facilities provided by the Internet refers to a contradiction between the philosophy and the application of educational technology. Also, there is no use of the facilities provided by the World Wide Web to enrich the course and its activities. These facilities include the flexibility of time and place, and the variety of teaching aids that suit the nature of different types of learners and instructors.

Although, the computer courseware dominates the field of Web-based Instructional System (WbIS) design, the role of the educational specialists is marginal and evaluation techniques for the courses designed using these tools are lacking. Thus, a new tool is needed to enable the educationalists to apply their theories in the this field. Moreover, WbIS design needs a framework that includes all participants in the project.

Over the past decade, Activity Theory (AT) has found application in learning, Human-Computer Interaction [1], and work practices [2]. From a methodological standpoint, AT accounts for cultural, institutional, and social settings, and therefore provides a holistic macro-analysis. It provides conceptual resources to capture elements of a complex setting, allows for a varied set of data collection techniques, and emphasizes the user's point of view [1].

In the field of Human Computer Interaction (HCI), Usability is defined as *the quality of an interactive computer system with respect to ease of learning, ease of use, and user satisfaction* [3]. Thus, the objective of interactive system design -which is our case in WbISs design- is to develop systems that are easy to learn, effective to use and provide an enjoyable user experience.

Thus, the present study aims that the learners reach the state of Optimal Experience (OE) in dealing with the educational situation as it is the desirable experience for achieving learning in general and especially Web-based learning. The study investigates the possibility of designing a WbIS project using AT as a framework infusing constructivist environment and andragogy theories that could increase the opportunities of optimal experience compared to other kinds of experience defined by specialists.

The organization of the rest of the paper is as follows: Section 2 presents the concepts of Usability and User Experience, Section 3 presents the concept of Optimal Experience from a theoretical perspective, Section 4 presents the background about Activity Theory, Section 5 presents Web-based Instructional Systems, while Section 6 illustrates different aspects of the case study presented. Finally Section 7 summarizes the conclusions, presents recommendations of this study and points out some future research directions.

2. Usability and user experience

Usability has been defined in Human Computer Interaction terminology as: "*the extent to which an application is learnable and allows users to accomplish specified goals efficiently, effectively, and with a high degree of satisfaction" [3].* 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 content that is relevant and meaningful to them.

Usability goals in interaction design have been set as [3];

- efficiency (How accurately and completely users can accomplish tasks?),
- effectiveness (How quickly can users complete tasks?),
- safety (such as preserving Privacy and Data security),
- good utility (Does system provide enough functionality for users to accomplish necessary tasks?)
- learnability (how easy a system is to learn how to use?), and
- memorability (how easy a system is to remember how to use, once learned?)

These can be measured and provide quantitative indicators for the extent to which productivity has increased, or learning has been improved. However, they do not address the overall quality of the User Experience (UE). Thus user experience goals are more subjective qualities and are concerned with how a system feels to the user.

So, why do so many e-learning applications fail to stress the importance of the UE or put it into practice? It is likely that the decision makers have a poor understanding of Usability and UE, are unaware of its importance, or do not consider it worthy of time and effort. Indeed, it would appear that far more energy is focused on the technology involved in developing instructional content rather than ensuring that users will be able to use the technology effectively [4].

There are many challenges associated with evaluating the usability of e-learning applications. For example, one challenge for e-learning applications is that they must accommodate the diverse backgrounds, experiences, and learning styles of users.

Another challenge is that while there are numerous approaches to measuring usability, readily available and accepted standards of e-learning application development have yet to be developed. Even so, many of the same principles advocated by the usability and user interface design community, such as learner-centered design, iterative design, and ongoing testing, apply to the development of e-learning applications.

The Learner-centered design, for example, states that you should know your learners and address the fact that they represent diverse backgrounds with different characteristics. Effective e-learning application development will seek to answer the following questions:

- How do learners prefer to learn?
- How are they currently learning the information?
- Under what pressures (for example, demands of their job and schedule) do the learners function in their day-to-day life?
- What is their motivation or incentive to engage in online learning?
- What constraints, such as Internet connection speeds or computer platforms, do they face?
- What special accommodations do learners need?
- How comfortable are they using online applications?
- What experience do they have with e-learning?

While the usability and educational effectiveness of an e-learning application are not one and the same, the two arguably have very much in common. Even though many organizations have made great strides in their ability to develop and deliver e-learning programs to their employees, customers, and suppliers, the usability of these e-learning applications is often lacking or entirely overlooked. Given the large investments organizations are making in online training, and the unique needs of learners, it would be prudent to address the usability of e-learning applications. Doing so will help ensure that users can actually access the necessary material, have optimal levels of satisfaction (optimal experience) with the learning environment, and enable the organization to maximize its e-learning investment.

3. The concept of flow: optimal experience

Flow is the state in which an individual feels cognitively efficient, motivated, and happy [5]. When in the flow state people become fully engrossed in their activities, irrelevant thoughts and perceptions are screened out.

In school learning environments, Flow is considered desirable and highly functional, and has been linked to other factors of learner engagement, continual motivation, psychological health, and a sense of learner well-being[6]. However, this philosophical view of flow describes mental states well beyond the scope of the current research framework. In this paper, we are interested in Flow states which might occur within specific circumstances or environments. In our case, we focus on flow within a specific learning environment, namely during Web-Based Instructional activities.

It is common that in certain computer-based environments - gaming, for example, or Internet chat rooms-users might become so lost or engrossed in the activity, that they can be said to 'tune out' the outside world. Such intense engagement by these computer users has begun to be studied by educational researchers keen on creating more motivating learning environments. [7] for example, is interested in why computer games are so attractive and attempts to draw connections between the work of Csikszentmihalyi and other motivational theorists to make instructional games more motivating for the users. He suggests that designing computer-based learning activities to increase learner curiosity would also improve learner enjoyment and flow. Similarly, [8] creates a set of multimedia guidelines for computer games and learning environments which are intended to enhance key flow characteristics. The intention is that if current research can help to identify the related factors that make flow experiences possible in WBI, the instructional designers and instructors of WBI might greatly benefit from ideas on how to provide optimal Flow experiences to their students. We ask, “Can the learner experience flow in Web-based Instruction?” and “what are the factors involved in learners having an optimal flow experience?”

Optimal experience is defined as a function of two variables; the challenges involved in the activities as well as the skills that the user has in order to face these challenges. According to the three state model by [9-10], there are three states that the user might be in (as shown in fig. 1); relaxation, anxiety and flow.

- The *Flow* state results when a balance exists between the challenges and skills levels.
- The *Relaxation* (Boredom) state results when the skills level is higher than the challenges, and
- The *Anxiety* state results when the challenges level is higher than the skills level.

4. Activity theory

Activity theory has evolved through three generations of research [11]. The first generation drew heavily on Vygotsky’s [12] conception of mediation. The idea was crystal lised in Vygotsky's famous triangular model in which the conditioned direct connection between stimulus (S) and responses (R) was

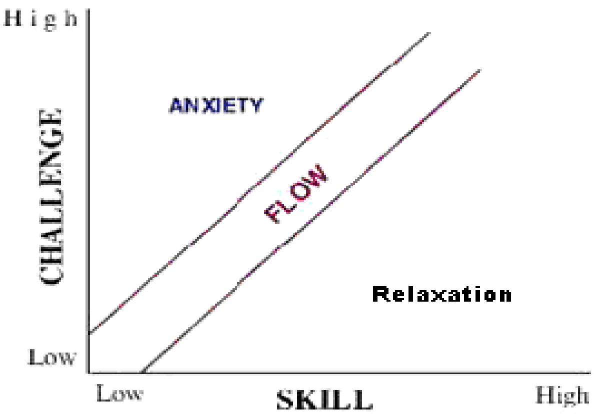

Fig. 1. Pearce model of experience [9].

transcended by a complex mediated act. The limitation of the first generation was that the unit of analysis remained individually focused. This was overcome by the second generation, based on [13] work. In relation to Leont'ev, [14] advocates the study of tools or artefacts as integral and inseparable components of human functioning. He argues that the focus of the study of mediation should be on its relationship with the other components of an activity system. The third generation of activity theory takes joint activity or practice (rather than individual activity or practice) as the unit of analysis for activity theory.

The aim of the third generation of activity theory is to understand dialogues, multiple perspectives and networks of interacting activity systems. In activity theory, the human mind emerges, exists and can only be understood within the context of human interaction with the world and this interaction, i.e., activity, is socially and culturally determined [15].

The basic unit of analysis in activity theory is the human activity. Human activities are driven by certain needs where people wish to achieve certain purposes. It is obvious that activity cannot exist as an isolated entity. The very concept of activity implies that there is an agent who acts (an individual or collective *subject*). An activity is undertaken by a *subject* (individual or subgroup) using tools to achieve an *object* (objective) thus transforming objects into outcomes -the term object here is not the same as object in object-oriented programming. Relations between elements of an activity are not directed, but mediated. The relationship between subject and object of activity is mediated by a tool. A *tool* can be anything used in the transformation process, including both material tools and tools for thinking. Transforming the object into an outcome requires various tools (e.g., computers, software, methods, ideas, procedures, Internet, paper, pen etc.). The object is seen and manipulated not *as such*, but within the limitations set by the tools [16]. *Artefacts* are created and transformed during the development of the activity itself and carry with them a particular culture; a historical remnant of that development.

The relationship between the subject and the *community* is mediated by rules. *Rules* cover both implicit and explicit norms, conventions and social relations within a community as related to the transformation process of the object into an outcome. Rules may consist of organizational practices and policies, working hours, working regulations, etc. The relationship between object and community is mediated by the *division of labour*: how the activity is distributed among the members of the community. That is, the role each individual in the community plays in the activity, the power each yields and the tasks each is held responsible for. Each of the mediating terms is historically formed and opens to further development [16]. The basic structure of an activity can be illustrated as in fig. 2. Activity theory sees learning as a situated and social activity and interlinks the individual and social levels [1, 15].

The basic unit of analysis in activity theory is an Activity, which includes a *context*. Al though time is a crucial part of context, fig. 2 does not reflect this. It is important not only to include current time, but also past time (a history element of context) and future time (to allow for prediction of a user's action from current context). Indeed, the skills of the learners increase with time as well as the challenges. During this conflict, the optimal experience increases and the outcome of the activity improves. Thus in fig. 3 [17], we add the two axis of Challenges and Skills to the activity history in order to illustrate the progress of experience with time (at different contexts).

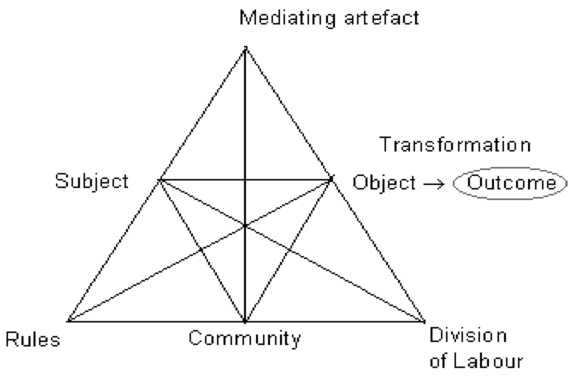

Fig. 2. Basic structure of an activity.

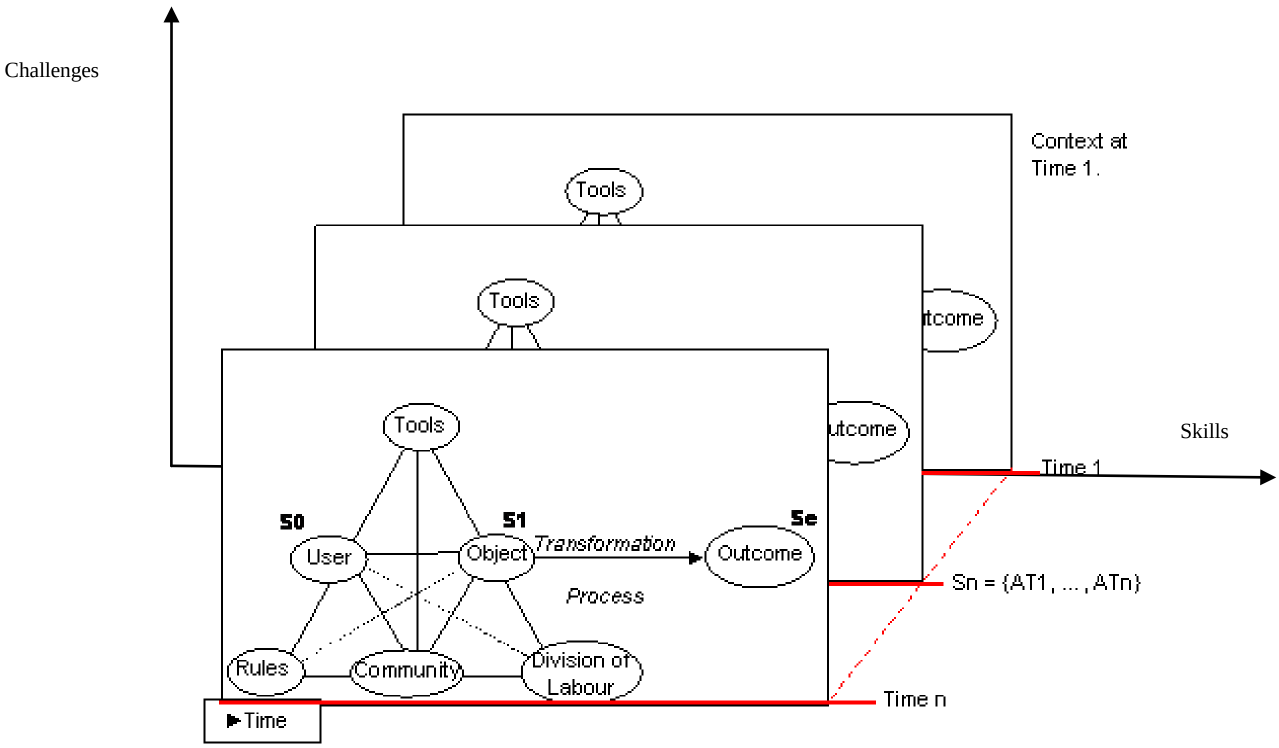

Fig. 3. Representing the history of activity and optimal experience.

Over the past decade, activity theory has found application in learning, human-computer interaction [1], and work practices. From a methodological standpoint, AT accounts for cultural, institutional, and social settings. It provides conceptual resources to capture elements of a complex setting, allows for a varied set of data collection techniques, and emphasizes the user's point of view [1].

The following subsection introduces some related work in HCI that lead to the proposal of using AT as a framework for capturing the requirements of web based systems and interaction design.

4.1. Why activity theory in HCI design?

From [18] according to [15], traditional approaches to HCI requirements analysis were dominated by the cognitive approach. This approach is characterized as transformation of human processing caused by new artefacts. Although this perspective appears to be useful in certain respects, there are several shortcomings. These include [15];

- the cognitive approach separates cognition from action and is only interested in the former,
- mental processes other than cognitive ones, such as motivation and emotions are considered to be outside the scope of analysis, and
- social interaction is rarely the objective of cognitive studies.

Thus there is an emerging consensus among researchers that the cognitive approach to human-computer interaction may be limited. It does not provide an appropriate conceptual basis for studies of computer use in its social, organizational and authorial context, in relation to the goals, plans and values of the user or in the context of development [19]. Activity theory provides a broad theoretical framework for describing the structure, development and context of human activity.

Indeed, in the context of Web engineering, Web applications require a more extensive and detailed requirements engineering process because of the number of stakeholders involved and the diversity of the requirements including, among others, requirements on the navigation [20]. However, navigation is often ignored at the requirement stage of development. For instance, approaches such a Web services distributed management [21] although proposed as a task-based model, is used in the definition of business processes and requirements are textually described by means of *Scenarios*.

Other approaches such as UML-based Web Engineering (UWE) [22] or Object-Oriented Hypermedia (OOH) [23] introduce the definition of Use Case diagrams to specify Web application requirements and the different kinds of users. In addition, a process model (based on tasks or activities) is included to model the business process of web applications. However, this model is used to complement a preliminary Class Diagram already defined from use cases. In this context, decisions about navigation must be taken from *Use cases*.

The Object-Oriented Hypermedia Design Model (OOHDM) [24] introduces techniques for early requirements handling. Text-based descriptions of use cases are complemented with *user interaction diagrams*, each of which graphically describes the information exchange between the application and the user in order to detect the navigational requirements. This approach mainly focuses on capturing the hypermedia design of Web applications. Interaction diagrams describe the information the user can access in every step of a *use case* as well as the operations the user can activate.

However, they do not consider relations between different interaction diagrams. This problem can be solved by capturing requirements by using AT notions that introduce concepts such as activity, action and operation which are related throughout precise relationships. These concepts together with their relationships can be used to support the definition of navigational requirements which are special for Web based applications [18].

An activity theory based method for HCI research and practice was suggested in [25]. This work introduced the 'Activity-Oriented Design Method' (AODM) both as a practical and analytical method for using AT within HCI design. Others like [26] have proposed AT-based methodologies. However, according to the concept of methodology adopted by the software engineering community, Mwanza's work [25] describes mainly the development process of a methodology and introduces an additional notation, which is not clearly explained. In other words, it does not present all the components of a methodology. On the other hand, Korpela et al. [26] only implicitly describes the development process of a methodology and does not discuss any other additional components [27].

5. Web-based instructional systems

Instructional systems aim to support and partially automate the instructional process on a subject field, which might concern, for example, a course, a seminar or even a series of lectures [28]. From a different perspective, these systems intend to satisfy certain instructional needs for a subject domain, which have surfaced mainly because of the advances in research and technology, the emergence of the information society and the globalization of markets [29].

Nowadays, instructional systems make extensive use of network technologies, especially the Internet and the World Wide Web, because of their potential, in advancing interactivity between learners and tutors, in offering flexibility concerning the way of learning, and in providing easy, one-stop maintenance and reusability of resources. This trend entails the construction of complex instructional systems, i.e., the WbIS, that incorporate a variety of organizational, administrative, instructional, and technological components [30]. The pursuance of quality in such complex systems is of paramount importance, although building high quality WbIS within specific time and fund limits is definitely quite a challenging task. There is no standard process to achieve this goal but the most promising approach seems to be the adoption, on behalf of the instructional designers, of a design and development model so as to reap several benefits [31], such as: improving the possibility of concluding the development process on schedule and within the estimated budget, assuring that the quality of the development process per se and the end product is guaranteed, standardizing the construction of new systems and consequently maintain and upgrade them more easily than ad hoc developments and putting emphasis on reusing parts of previously developed compliant systems, on a design or implementation level, thus reducing the development time and costs.

Instructional systems are constructed to solve specific instructional problems. In effect, the development process for WbISs should follow the principles of a problem-solving approach. This approach unfortunately cannot be generalized and automated, since each instructional development project is unique. In effect, it requires both the methodological solution and the development process to be based solely upon the given needs and requirements [32]. In order to come up with the best solution, the instructional design group initially needs to make a description in non-technical terms of a solution to the given problem (which stems from instructional needs) as precisely as possible. At first, the instructional problem solution should not entail technicalities on how it will be implemented, but it should contain possible technical or ergonomic constraints, so as to leave space for several design and implementation options [33]. Thus, the WbIS development process is divided into the two phases described next.

5.1. The non-technical solution

The definition of the "non-technical" solution to an instructional problem can be generated by blending five interrelated sets of learning elements: the learning objectives, the didactic events, the syllabus, the assessment procedure and other issues like prerequisites, fees, technical constraints, etc. Having this formulated description as an input, the instructional designer should proceed in creating the architectural blueprint of the WbIS that will constitute a realization of such a solution. Thus, such a "non-technical" solution, that is the instructional problem abstract solution, plays the role of requirements specification for the WbIS under construction [33]. This solution still has a methodology or framework to present it to the technical people.

5.2. The technical solution

Consequently the design process of a WbIS transforms the "non-technical" solution of the instructional problem into a technical one. According to [33], the architectural blueprint of an instructional system includes descriptions about four interrelated subsystems.

• The human subsystem, which describes the roles, in as much detail as possible, for each kind of human agent involved in the instructional process.

• The web-based learning resources subsystem, which is perceived as a mosaic of online learning resources. Such learning resources can be course notes, slide-ware, study guides, self-assessment questionnaires, communication archives, learning material used for communication purposes, etc.

• The non web-based learning resources subsystem, like textbooks, papers, audio/video cassettes, CDs, DVDs, etc.

• The technical infrastructure subsystem, which is divided into common and special. An instructional system basically makes use of services from common infrastructure, which is a set of learning places, that support student learning in general (e.g. laboratories, networking facilities, etc.). However, in order to best support the instructional process, special infrastructure should be created (e.g. multimedia conferencing systems, state of the art hardware components, a specific learning management system, etc.), which will provide services unique to a particular instructional problem [34].

6. Designing a web-based instructional system using activity theory

This section presents the work done in this paper which is based on a cooperation between the Computer Engineering Department and the Department of Education Technology and Curricula in the Faculty of Education. The study started by the design of a Web-based course adopting the AT for the system requirement analysis and as a framework for evaluating the learners' experience with the course and the courseware used to implement it. The below subsections describe the case study, discuss the optimal user experience evaluation criteria, and summarize the research statistical results.

6.1. Case study: a web-based educational technology course

A Web-based course on Educational Technology is designed for the students of second year special diploma (Educational Technology section) at the Faculty of Education. The sample consisted of 24 graduate students.

The cornerstone of the special technological infrastructure subsystem was the Moodle learning environment (http://www.moodle.org). The platform hosting Moodle included the PHP language, My SQL database management system, the Apache web Server, and was installed under the Linux operating system. This environment hosted the web-based learning resources (webware), the details about students and instructors (personal data and records), and the data used for administration (course management). An ordinary WWW browser (like Netscape Navigator, Internet Explorer) was adequate to browse through the material of the learning resources.

The students studied a web-based educational technology course which included four types of *activities* on the internet:

- writing diaries before and after reading,
- group discussion based on a written text
- writing diaries after the discussion, and
- writing reflexive articles at the end of the topic.

6.2. Measuring optimal experience

Related studies have measured optimal experience by the Experience Sampling Method (ESM) either by short or long questionnaires. This measure is repeated several times along the instructional task based on a perspective of the optimal experience as a *process* [35]. Other studies measure the optimal experience as an *overall state* at the end of the instructional task [36]. In this paper, we adopted the method used in [9] which combines both. This combined method illustrates the interaction between the learner and the task by plotting the experience path of each learner along the instructional task, i.e., throughout the learner interaction with the activities and the learning material delivered along the course delivery time.

The above four activities are repeated five times for five different topics. A *formative test* of Optimal Experience was applied after the reflexive diaries and the reflexive articles. A *summative test* of experience was applied at the end of each topic. The *effectiveness* of the course for achievement and skills was measured and the relationship between the frequencies of the Optimal Experience as a process and as an overall state was investigated as well as the relationship between the overall state of the experience and the achievement level. The main question of the study is: What is the Optimal Experience of special diploma students at the Faculty of Education, participating in the web-based educational technology course designed using AT as a framework? This question could be sub-divided into the following questions:

- What is the effect of the designed course activities on the achievement of *conceptual* and *procedural* knowledge of the students referred to?
- What are the ratios of OE (as a process and as an overall state) among the learners during their performance of the activities of the course?
- What is the relationship between students scores on the scale of OE as a process and their scores on the scale of the OE as an overall state?
- What is the relationship between the ratio of the cases of OE as a process and its ratio as an overall state?
- What is the relationship between students' scores on the scale of OE as an overall state and the level of students' achievement of conceptual knowledge related to the course?

The study also investigates the following qualitative questions:

- To what extent are the paths of the Optimal Experience as a process identical for students of the sample?
- What is the students' perception of the course?

The sources of qualitative data are reports and comments on the course while the sources of quantitative data are:

- The scale of OE as a process (challenges-skills) as a *formative evaluation.*
- The *Summative evaluation* for measuring the OE as an overall state.
- The Achievement test which consists of two parts: the first is multiple choice for the *conceptual knowledge* and the other is essay questions for the skills of *procedural knowledge.*

The collected data from students during the learning process was analyzed using the SPSS 16 statistical package. The following subsection presents some of the statistical results. For more details refer to [17].

6.3. Discussion

Fig. 5 shows the percentage of optimal experience for the students throughout the course for the five different topics using both methods of measure. Statistical results indicate significant differences in favour of the post-test scores on the achievement test; the frequencies of OE state reached (28.6%) compared to the Anxiety state (22.5%) and the Relaxation state (48.9%) in the course as a whole; there were no recency effects for any of the activities in the first, second, fourth and fifth topics. However, there were recency effects on the third topic. Statistical results derived using the SPSS 16 statistical package are summarized as follows:

- Significant differences were found at the level of (0.01) between the mean scores of students on the achievement test of conceptual knowledge in favour of the post-test scores.
- Significant differences were found at the level of (0.01) between the mean scores of students on the achievement test of procedural knowledge in favour of the post-test scores.
- The frequencies of OE state reached (28.6%) compared to the Anxiety state (22.5%) and Relaxation state (48.9%) in the course as a whole.
- There were positive correlations between the scores of the scale of OE as a process and the scores of the scale of the OE as an overall state.
- There were positive correlations between students scores on the scale of OE as an overall state and their scores on the test of conceptual knowledge in all topics except the first.
- The ratio of students who reached the OE as an overall state reached 55.84%.

Fig. 4. The Home page of the education technology course website.

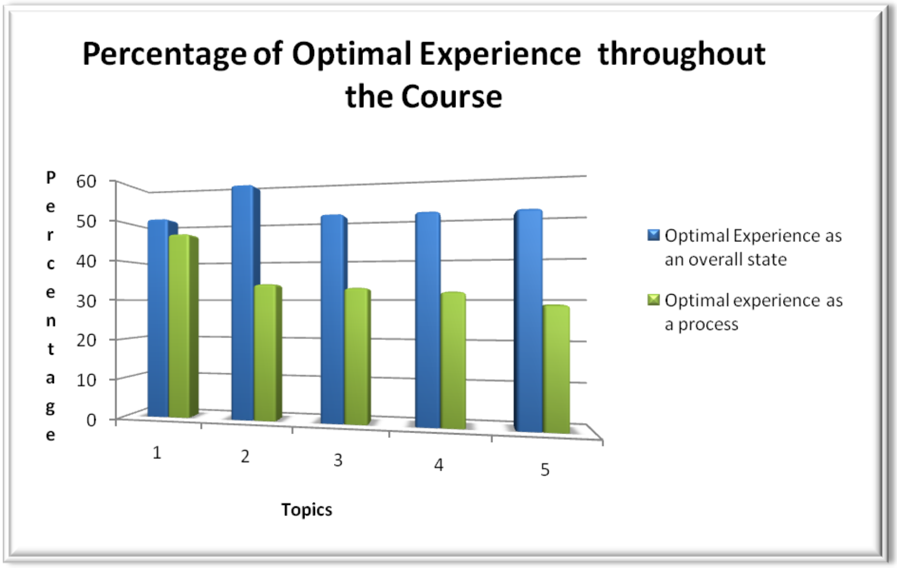

Fig. 5. Percentage of optimal experience throughout the course.

- The content has an effect on the OE as a process and as an overall state.
- Every student has his own path in the OE with the five topics as shown for the three students in fig. 6.
- The better scores students get in the achievement of conceptual knowledge test, the better their scores on the scale of OE.

7. Conclusions and future work

This paper presents the results of adopting the activity theory as a framework for the analysis and design of a WbIS. The main objective is to enhance the usability evaluation parameters by inducing optimal experience in learners. The case study conducted on the Faculty of Education students revealed a lot of interesting results and promoted a lot of future work in multi disciplines; Education specially E-learning, Human computer Interaction, and Web Engineering. The study revealed that Activity theory represents a valuable tool for the analysis of software requirements specially for Web-based applications such as WbIS. Some of the recommendations of the study are;

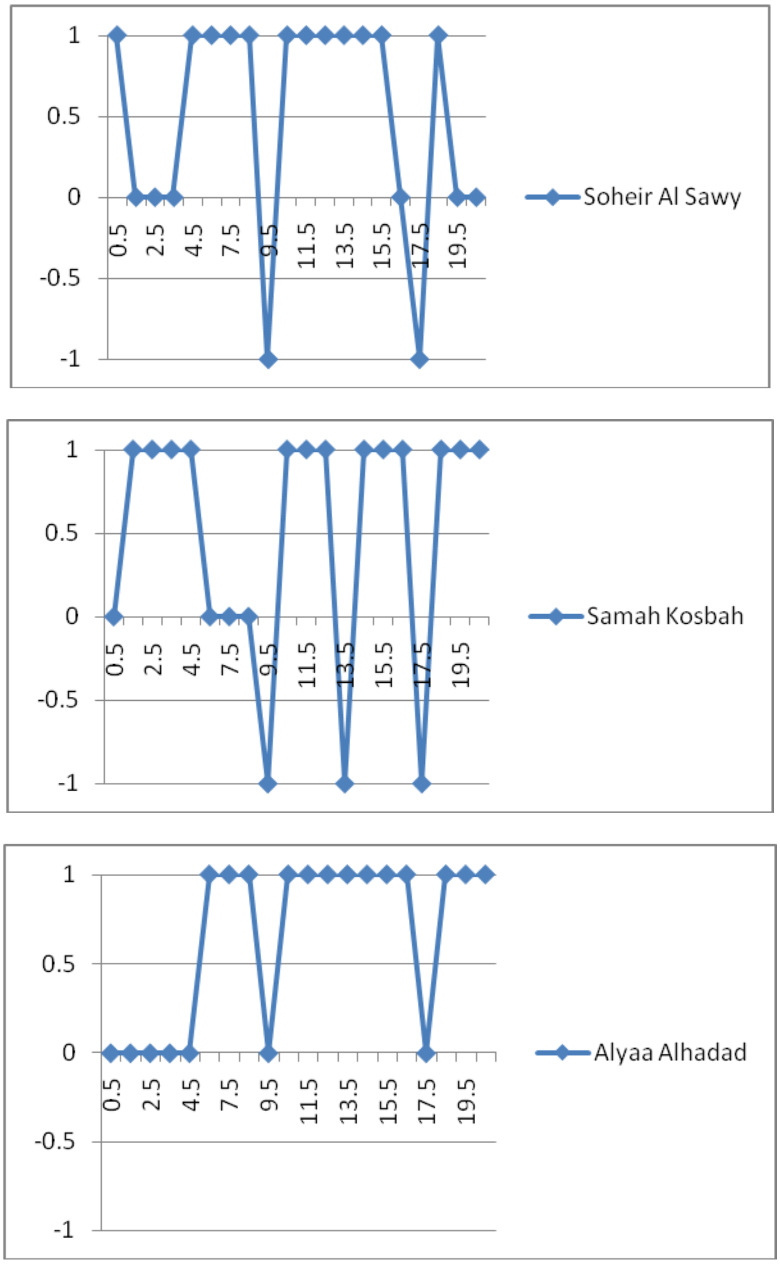

Fig. 6. Optimal experience paths of three students.

- Adopting the Activity Theory as a frame work for designing courses on the web in light of the multi-participants in the project.
- Concentrating on designing reflexive activities depending on critical thinking and retrospection, and variety of activities with the same content. Also, opening different forums for participatory discussions.
- When designing courses on the web, we should take care of the variety of activities with some constant activities for communication and focusing on practical skills of E-Learning.
- Using both E-Learning and face-to-face learning as the results of research indicate that the later is effective in many ways.

- Connecting brain-based learning with instructional design.

Future research directions include research in different disciplines as it is a result of a joint work between the Computer Engineering Department and the Education Technology department. Some of the future research ideas are for educational specialist while others need the contribution of computer engineers or need the cooperation of both as the current study presented in this paper. From the computer science perspective, some of the future research directions are;

- Developing methodologies for Web Engineering specially based on AT and exploiting them in Course Management Systems (courseware) that help the educational specialists to construct their courses based on AT.
- Studying requirements engineering methodologies for using them in courseware packages in order to create new educational systems on the web, based on the educational technological model. Hence, the education terminology should be part of the CMS in order to reflect the course creator / tutor needs and reach the objectives of the course.
- Using Web Usage Mining techniques for user modeling to explore usage patterns and evaluate the learners' satisfaction about Web-based Instructional Systems. Thus optimal experience paths can be plotted and different users' needs are identified.
- Enhancing other usability factors of Course Management Systems (CMSs) (courseware) to be better for learners as well as course designers. Moreover, studying other factors such as efficiency, effectiveness, learnability, memorability with respect to the different human agents related to the system specially the learner and course creator.
- Studying evaluation techniques and methods to collect data from the field and focusing on both qualitative and quantitative measures.

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