

THE NATURE OF AN APPROPRIATE ENVIRONMENT FOR TEACHING AND LEARNING INFORMATION SYSTEM DESIGN

MARIA JAKOVljević

Dr Maria Jakovljević is currently a senior lecturer in the Information Systems, School of Economics and Business Sciences at University of the Witwatersrand.

School of Economics and Business Sciences, University of the Witwatersrand, Private Bag 3, Wits 2050, South Africa. Tel +27-11-717 8159; Fax +27-11-717 8139; E-mail: jakovm@sebs.wits.ac.za

PIET ANKIEWICZ AND ESTELLE DE SWARDT

Both Prof Piet Ankievicz and Prof Estelle de Swardt are professors of Technology Education at the Rand Afrikaans University.

Department of Curriculum Studies, Rand Afrikaans University (RAU), P O Box 524, Auckland Park, Johannesburg, 2006 South Africa

ABSTRACT

One of the major obstacles facing project managers and information system designers is creating an appropriate environment to excel system design skills. Instruction in information system design (ISD) environments are responding to the increasing demands posed by time and complexity through investigating a variety of tools, system design methodologies and software technologies. The intention is to help learners/information system designers to take more control over their own learning process and to demonstrate system design skills.

The aim of this paper is to identify and discuss the nature of an appropriate environment for ISD created through the Instructional Web Design Programme (IWDP) motivating the learners to excel while trying to learn and understand concepts and techniques that relate to information systems.

This research was based on a qualitative, action-research approach where individual interviews, focus group interviews, observation and document analysis were used to gather data [1,2]. Seventeen students at an institution of higher education were observed and their experiences were investigated through a focus group interview, journals and essays. In addition, an interview with the teacher was performed to investigate her thoughts and feelings during the implementation of the IWDP.

The most important findings were:

Available physical, human and financial resources and its elements set a basis for creating an effective climate for teaching of information system design; the elements embedded within the physical, human and financial resources assist learners in obtaining an understanding of design procedures.

Keywords: Information system design, web design, instructional web design program, technology education, technological process, learning and teaching environment

1. INTRODUCTION

Though numerous research reports have provided a body of information about a wide range of techniques in software design and development [3,4] far less research has been conducted on those aspects of software analysis and design that meet the design needs of learners in an Information Systems Design

The research questions addressed in this paper are:

1. What are the elements of an appropriate environment for ISD?
2. How can one incorporate these elements of an appropriate environment for ISD in a learning programme for students at an institution of higher education (HEI)?
3. What are the effects of these elements of an appropriate environment for ISD on learners' understanding of concepts and techniques that relate to information system design?

The system design methodology incorporated in the Instructional Web Design Programme (IWDP) is tailored in such a way to allow learners to take into the consideration the necessary tasks and activities to be performed, the knowledge base that must be developed and the expected learning outcomes.

For the purpose of this study, on which the article reports, an Instructional Web Design Programme (IWDP) has been developed and implemented to help students fulfil the complex, multiple tasks of problem solving during an information system analysis and design. The program was based on the new outcomes-based (OBE) school curriculum in South Africa, which is aimed at developing creative problem solving skills in every learning area [9, 10]. OBE focuses, amongst others, on critical thinking, effective communication, and problem solving [11].

ISD in the presentation of a learning programme.

(ISD) environment. There is little in the research literature on mind tools and graphical techniques that will engage learners in the development of system design skills. Mind tools are computer tools that are intended to engage and facilitate the cognitive processing of learners [5,6,7].

Learners should be involved in informal learning activities such as knowledge sharing, experimentation and environmental scanning in order to achieve reflective learning [8]. There are no studies, however, which indicate what elements could promote learning and teaching demand and a lack of time for learning pressure, complex demand and a lack of time for learning and teaching context, which is characterised by great such environment particularly in the ISD context. The ISD learning and teaching context, which is characterised by great pressure, complex demand and a lack of time for learning and teaching context, which is characterised by great

then integrate the elements of an appropriate environment for

2. THE FRAMEWORK FOR AN APPROPRIATE ENVIRONMENT FOR TEACHING AND LEARNING INFORMATION SYSTEM DESIGN

This section outlines the framework for an appropriate environment for ISD.

2.1 Elements of an appropriate environment for Information System Design: Integration within the Instructional Web Design Programme (IWDP)

To help learners develop a deeper understanding of ISD and to expand thinking skills, knowledge and values the following resources are considered essential:

- Physical resources
- Human resources
- Financial resources

This research asserts that the elements (see par 2.1.1, 2.1.2 and 2.1.3), which are embedded within physical, human and financial resources, provide learners and the teacher with an appropriate environment for learning and teaching ISD. The elements are inter-dependent and interact with each other to form a dynamic structure for teaching and learning in a project-based classroom.

2.1.1 Physical resources

Organising physical resources could facilitate learning transfer as the learning process of ISD is embedded in the classroom environment and real-world environment, thus fulfilling the enabling factors of informal learning [11].
 "The importance of informal learning in professional development has focused greater attention on the interplay between informal learning and the organizational environment where this learning occurs" [8].
 The following variety of elements of physical resources will help to structure the learning environment so that it is more conducive to self-initiated engagement with ISD:

- a) *Venue (Computer lab)*: Organising the physical appearance of the computer lab as a real-life environment (for example placing posters, diagrams on the notice board) leads the learner into the realms of imagination as the learning process "must take place in contexts that resemble the situations in which the knowledge and skills will be used" [12]. The computer lab should be equipped with an appropriate network facility [13] lights and have a printer, scanner and/or copier machine. The arrangement of furniture is necessary to provide opportunity for individual, cognitive apprenticeship and group discussions. In addition, a quiet atmosphere should be organised and a place should be provided to keep statistics, journals, documents, reference and library books, encyclopaedias and magazines.
- b) *Learning support*: Educational medium (for example, the visual organizer on the board) help learners, during discussions and brainstorming, to list ideas, plan steps for practice and list the requirements and actions necessary for each stage of the technological process [11]. A more productive approach to foster ISD could be achieved by developing the following off-line material:
 - a web design checklist (WDC);
 - a web evaluation checklist (WEC);
 - a performance indicators checklist (PIC);

In the next section, we focus on human resources that sensitively act within the physical environment making use of its elements for effective teaching and learning in an ISD context.

- c) *Graphical techniques*: In facilitating the understanding of key business processes and requirements it is necessary to introduce different graphical techniques: synthesizers, advanced organizers, historic and emerging organizers, and purpose of the CDFD is to visually depict procedural knowledge pathways [14]. Boden [15] suggests that vision is the most powerful human sense, having "evolved to notice spatial relations such as connectedness, juxtaposition and gaps", which can be applied in the ISD context.
- d) *Hardware*: The computer lab should be equipped with appropriate desktop computers. For example, Pentium 5 with 20 GB Hard Drive, Network Cards and 14" monitor.
- e) *The software tools*: Many learners have no experience or knowledge on how to use software tools to represent personal interpretations [7]. The following *mind tools* have been introduced to form an appropriate environment for teaching and learning ISD:
 - *Semantic networks* are special representations of ideas and their interrelationships within the human memory structure [16, 7]. Von Wodtke [17] states that semantic diagrams by means of their visual power help to articulate concepts and relationships between concepts, forming new insights into relationships between them.
 - *Computer mediated communication (CMC)* serves as a vehicle for delivery and sharing the product of any mind tool between learners [7]. Using CMC makes activities independent of time and place, allowing messages to be sent, received and "...discussions can proceed in a more non-linear, simultaneous fashion" [18].
 - According to Swan and Black [1990], *computer programming* is a problem solving tool if particular problem solving strategies (for example, problem decomposition, generating hypotheses, and gathering evidence to support those hypotheses) are applied to real world problems. Dover [1983] points out that computer programming facilitates the development of abstract thinking, problem solving and logical thinking.

In addition, a preliminary selection of the appropriate *software technology* must be made in order to integrate the visual design with functionality based on the preference and the existing hardware requirements [11]:

- The development platform architecture (for example, Windows operating system, Personal Web Server (PWS), Active Server Pages (ASP), The database (MS Access), the Internet browsers (Internet Explorer, Netscape Navigator))
- The development application architecture (for example HTML, JavaScript, Cascading Style Sheets (CSS), Java Applets)
- Production platform architecture (for example, Windows NT, IIS (Internet Information Server), Active Server Pages (ASP)) [3]
- Time: Literature confirms the importance of time constraints in learning [21, 22]. The idea of time constraints and time planning for each phase and deliverable of ISD [11] are crucial elements of an appropriate environment for ISD.

2.1.2 Human resources

Creating a multi-method learning environment is possible, if a network of human resources (teacher, a senior tutor, peer-tutors, an assistant, technical assistant) is provided in an ISD context.

a) *The teacher should acquire different roles (such as: mediator of learning, interpreter and designer of learning programmes and materials, learning areas/sub-disciplinary phase specialist) and competences (foundational, practical and reflective competences) [11].*

The teacher should have essential *instructional skills* (for example, organizational, instructional alignment, focus, feedback, monitoring, communication, questioning) and positive affective characteristics (for example, enthusiasm, modelling, warmth, empathy and a positive frame of mind) [11].

The teacher should be well equipped with *project management competences* (business achievement competences, problem-solving competences, influence competences, people management competences, self-management competences) [23].

b) *A teaching assistant prepares for individual guidance and group tutoring in a time and place convenient for learners; must be familiar with practical and cognitive apprenticeship. A teaching assistant should have a proven record of knowledge and skills in system design and reinforce the social-interaction and system design skills of learners. The teaching assistant allows intrinsic feedback on the description [24]. An assistant coordinates the actions of peer-tutors.*

c) *Peer-tutors teach a topic, skill or concept to members in the group or across the different groups according to a time schedule.*

d) *Technical assistant is an expert involved in providing expertise in terms of technical knowledge and skills for software and hardware.*

By delegating practical responsibilities to a teaching assistant, technical assistant and peer-tutors, the teacher is provided with more time to be involved in cognitive apprenticeship. The learning experience of ISD is enriched through social interactions as learners interact with experts in the project-based classroom. Taking into consideration the above resources the success of teaching and learning in an ISD context is determined by availability of financial resources.

2.1.3 Financial resources

Due to its complexity an ISD context demands extensive administrative involvement of the teacher [11]. The intent of financial resources is to assist the teacher to prepare physical resources and utilize her financial knowledge and skills of managing ISD. Financial resources should be available to *organize and manage the computer lab, to handle students' fees and the remuneration of a teacher, an assistant and technical assistant*. The financial resources must be planned in advance and skills in managing financial resources are essential for creating an appropriate environment of ISD.

An appropriate environment for ISD is organized in terms of the following: physical resources are prepared; a network of human resources are organized; financial resources are appropriately planned and managed.

Although these elements coexist in an ISD context, there is no literature that identifies how they are integrated into a learning programme, which could further improve the teaching and

2.2 Incorporating the elements of an appropriate environment for ISD in the Instructional Web Design Programme (IWDP)

The next section will indicate how the elements of an appropriate environment for ISD were incorporated within the Instructional Web Design Programme (IWDP).

The three pillars of the theoretical framework (mind tools, complex thinking, instructional models and strategies), serve as a basis for the derivation of criteria for the development of the Instructional Web Design Programme (IWDP) [11]. "Complex thinking includes goal-directed, multi-step strategic processes, such as designing, decision making and problem solving and this is an essential core of higher-order thinking" [7]. The term proposed for the purpose of this research is 'complex thinking' as an umbrella term under which all other sub-processes (creative thinking, critical thinking, decision-making, problem solving and design) and skills of higher-level thinking belong [11].

In addition, policy related to Technology Education and Outcomes-Based Education in South Africa, the conceptions of the teacher in a technology classroom serve as the further basis underlying the derivation of the IWDP [11]. Policy related to Technology Education and Outcomes-Based Education in South Africa highlights the necessity to meet the critical learning outcomes [26, 10] and specific learning outcomes [11] in any learning area including ISD.

The IWDP consists of the following components whose characteristics are shaped by criteria embedded in the theoretical framework on mind tools, complex thinking, instructional models and strategies [11]:

- *Theme.*
- *Critical outcomes (CO's):* Critical outcomes are generic cross-curriculum outcomes, which ensure that learners gain the skills, knowledge and values, which influence their own success and contribute to a wider community [27].
- *Specific outcomes (SO's):* include technological knowledge, skills, attitudes and values that help learners to understand and demonstrate achievements in technological contexts.
- *Assessment criteria (AC)* help to evaluate the processes (cognitive and behavioural) and indicate in broad terms the observable products of learning.
- *Range statements (RS)* indicate the scope, depth, and level of complexity of content, processes and context which learners should engage with, as well as parameters of the achievement [26].
- *Performance indicators (PI)* assist the teacher and learners by providing details of the content and processes that a learner should master.
- *Case study tasks* help learners to connect classroom activities with reality.
- *Resource tasks* guide learners through a variety of means (graphical techniques and mind tools) through which they build technological knowledge, creative, reflective and problem solving skills.
- *Capability tasks* spread across the stages of the technological process, which help learners to apply acquired knowledge and skills
- "Notional time represents contact time, learners' efforts and time, preparation time and other issues" [26].
- *Learner off- and on-line activities* are allocated for each task during the technological stages
- *Teacher activities (instructional strategies)* [28, 11, 29].

The IWDP contains instructional strategies for the purpose of explicit teaching of thinking skills and their attributes. One of the possible ways was to explicitly teach thinking skills in order to make learners aware of thinking processes and to develop their responsibilities to monitor and understand their thinking processes. Different thinking skills and their attributes [35, 36] were emphasised, explicitly explained and modelled to learners during ISD. Learners deal with the conceptual meaning and attributes of thinking skills in the ISD context.

3. RESEARCH DESIGN

Research approach

This research can be described as a qualitative, single case study [1, 2, 37]. Action research was applied to simultaneously investigate and create changes during ISD with new instructional strategies and tools.

Profile of the students, intervention and setting

In this study two distinct mixed cultural groups of learners were identified. These consisted of five second-year learners (2 females and 3 males - average age of 20) enrolled for the Information Systems Diploma at a Technikon, 12 first-year learners (5 females and 7 males - average age of 19) enrolled for the International Diploma in Computer Studies at a Higher Education Institution. Participants from the two groups presented a purposive convenient sample [2]. The purpose of choosing a small non-random sample was based on the researcher's intent to understand the phenomenon in depth [2].

The researcher of this study organised an extra-curricular classroom in a well equipped computer centre at a university and presented the IWDP in order to teach learners web design and to facilitate complex thinking [11]. The IWDP was presented once a week for 13 weeks, with duration of four hours per session. Learners worked on a real-world project that consisted of a car-purchasing scheme.

Data-gathering methods and analysis of data

The teacher conducted the classroom observations, which relates to an extensive description of the teacher's actions, thoughts and feelings related to instructional strategies, events, words and interactions of learners in the project-based classroom.

An experienced interviewer conducted the retrospective interview with the teacher and a focus group interview with the learners. Learners expressed their expectations of the intervention through an essay administered at the beginning of the course. They also expressed their experience with regard to the IWDP through journals written after each session of the course. Their experience of the adaptation of instruction was recorded in another essay during the IWDP.

Data was gathered through multiple data-gathering methods which satisfy the criteria for triangulation. The constant comparative method was applied to the data within interviews and between interviews [2]. The following measures were used for judging the validity of the research design: reliability, construct validity and internal validity [1, 2, 37].

4. RESULTS

The scope of this paper will only present and discuss findings relevant to the establishment of an appropriate environment for ISD. The following table presents categories derived from the teacher's and learners' experience of the IWDP:

Additional components of the IWDP are the stages of the technological process. The technological process (procedural knowledge) includes the following twelve stages: Statement of the problem; Design brief; Investigation; Proposal; Initial ideas; Research; Development; Planning; Realisation/Making; Testing; Evaluation and Improvement [28]. The stages of the technological process are cyclical and repetitive. "Design, modelling, problem solving, systems approaches, project planning, quality assurance and optimisation are all candidates for technological procedural knowledge..." [30,31].

The elements of an appropriate environment for teaching and learning ISD (see par 2.1) could be incorporated with the components of the IWDP.

Time as an element of physical resources was allocated within the IWDP as the teacher planned an approximate time for each stage of the technological process. No detailed time planning for the learner task and activities was performed.

Learning support (see par 2.1.1 b) was facilitated through a set of learner tasks and off line activities. By providing structured tasks [31] and activities, the learner has an opportunity to get an overview of the system. "Favourable conditions for learning exist when a person is faced with a task for which no known procedure is available" [33]. Tasks should be given according to the ability level of learners as well as prior experience [12].

Software tools (for example mind tools) and graphical techniques were taught through the predefined set of learner tasks and on-line activities and their corresponding teacher activities (instructional strategies).

Human resources (teacher, a teaching assistant, peer-tutors) were provided with the pre-defined set of AC, RS and PI embedded within the IWDP. A variety of pre-defined teacher activities (instructional strategies) were incorporated into the IWDP guiding the teacher through the complexity of organising an appropriate atmosphere for creativity and problem solving in a constructivist classroom.

Learning outcomes (critical (CO's) and specific outcomes (SO's) were communicated to learners before the implementation of the IWDP. Clear communication of the learning outcomes could improve learners' intrinsic motivation and individual responsibilities during the ISD [11].

Varities of learning approaches (for example, individual, collaborative, situated learning, inquiry learning, apprenticeship learning, peer learning, observational learning and experiential learning) were nurtured through the provision of learner case studies, resource and capability tasks within the IWDP [11]. Important aspects of informal learning, contextual learning, peer-based learning, activity-based and reflective practice [12] are incorporated in the project-based classroom, which could contribute to the effective creation of positive learning and teaching atmosphere.

This research assumes that the provision of different instructional strategies and learning approaches based on constructivism and behaviourism will extend learners' cognitive capabilities and ISD skills.

The IWDP was implemented in a computer lab, which served as a constructivist classroom where multiple interactions were possible reflecting individual and group dynamics and a variety of learning approaches and teaching strategies. Constructivists emphasise that learners need to be actively involved, to reflect on learning and to make inferences [30, 34]. Furthermore, behavioural principles on learning and instruction in a constructivist classroom were incorporated during ISD [11, 12].

Table 1: Categories relevant to teaching and learning in the ISD context

Teaching in the ISD context	Learners' understanding of ISD procedures
a) Available physical resources and its elements set a basis for the efficient teaching of concepts and procedures related to ISD	e) The physical resources provide the opportunity for the learners to gain understanding of concepts and techniques related to ISD
b) Human resources assisted the teacher with monitoring, teaching and administration tasks, creating an appropriate environment for ISD	f) Human resources helped learners to extend their knowledge and understanding of ISD procedures
c) Planning and managing of financial resources by the teacher are essential elements of an appropriate environment for ISD	
d) A pre-defined set of AC, RS, PI, learner tasks and activities set a basis for efficient teaching of ISD	

Finding regarding teaching in the ISD context
 Emerging from the interview and classroom observations relating to the teacher's experience of the IWDP, the following findings were made:

- a) Available physical resources and its elements set a basis for the efficient teaching of concepts and procedures related to ISD

The teacher wrote that the allocated computer lab with its equipment (a printer, arrangement of furniture, light fixture, hardware and software tools) provided a quiet and stimulated atmosphere for teaching ISD. Computers (15) were placed in rows with flexible arrangements of chairs and a technical assistant desk was placed in the corner. Learners were seen moving around and freely arranging their space and learning groups.

The teacher observed that: "... there was hardly any problem with software or hardware, as two assistants..." [a teaching assistant and a technical assistant] were present all the time".

During classroom observations the teacher noted that the careful planning of learning support (for example, visual aid on the board, worksheets, checklists, guidelines) and graphical techniques (for example, CDFD) contributed to the learners' imagination, full concentration, and reflection. This was evident through careful gathering and filing of the off-line material in their project files. It was also evident through their complete engagement during the ISD and their loud thinking and reflection during group discussions.

The teacher, however, reported that there was insufficient time allocated for some of the technological stages:

"They were coming once a week... Learners need more time for design... there was no time for modelling... More time should be allocated for the teaching of thinking skills and their attributes".

- b) Human resources assisted the teacher with monitoring, teaching and administration tasks, creating an appropriate environment for ISD

The teacher, commented in the observation protocol: "...while I helped to form collaborative groups and to perform cognitive

apprenticeship an assistant was involved with monitoring of team-building activities providing an explanation and demonstration of ISD concepts and techniques...

Observation notes revealed that the teacher guided a teaching assistant for discussions with learners. Topics covered were: how to set ground rules, model discussions, and how to master questioning. The teacher presented, demonstrated and discussed thinking skills and their attributes with learners.

The teacher noted: "... an assistant helped with on-line resource material (the internet knowledge base) software programmes and off-line material (handouts, library books, magazines)... the assistant helped me to handle administration tasks ... checking payments, making copies etc..."

- c) Planning and managing of financial resources by the teacher are essential elements of an appropriate environment for ISD.

The teacher wrote in field notes "... too many administration tasks, I don't have time... I have to check payments every day ..."

Classroom observations indicate that the teacher experienced the difficulty in handling financial resources. The time and tasks were not allocated within the IWDP, which put additional pressure on teaching ISD. The teacher was relieved when a teaching assistant provided help with some financial tasks at the beginning of each session.

The teacher noted during classroom observations that managing financial resources was an essential prerequisite for a successful web design course.

- d) A pre-defined set of AC, RS, PI, learner tasks and activities and a variety of teacher's activities set a basis for efficient teaching of ISD

The teacher commented that: "... it was very important to have a structure consisting of tasks, activities, assessment criteria, performance indicators... as well as a variety of the teaching actions which helped me to organise the work and to lead them towards thinking... with the structured work students had the feeling that they were being guided and had more time for research and solving the problem..."

The teacher observed that, it was difficult to interrupt learners, as they were completely occupied in dialogues, and discussions. Learners' engagement with dialogues and discussions were attributed to a variety of pre-defined learner activities and a variety of teacher's instructional strategies.

Finding regarding learners' understanding of concepts and techniques in the ISD context

Emerging from the interview, journals and classroom observations relating to learners' experience of the IWDP, the following findings were made:

- c) The physical resources provide the opportunity for the learners to gain understanding of concepts and techniques related to ISD

Learners commented in the focus group interview: "when you're designing a web page, there is a lot of tools that you can use to design it, we experienced a lot of things, we had to interview managers... we found material on the internet, there are different applications that you can use..."

The teacher noted in the observation protocol: "Learners tried to use standard data flow diagrams but they were complaining,

embedded within the IWD (as an answer to research question 2). Perhaps the elements of an appropriate environment for ISD were only effective through their sensitive integration within the IWD

Providing multiple resources (physical, human and financial) and simulating the learners' real environment through a variety of learning approaches (for example, individual, collaborative, situated learning, inquiry learning, apprenticeship learning, peer learning, observational learning and experiential learning) and a variety of teacher activities to choose from (for example, explanation, demonstration, modelling, questioning, discussions, dialogues, inquiry/investigation, lecture, whole class instruction) was possible through the pre-defined coherent structure of the IWD. This influenced the understanding of concepts and technique relevant to information systems and the learner's self-motivation (as an answer to research question 3).

During the implementation of the IWD, multiple learning approaches and teaching activities enlarged the learners' understanding of ISD design procedures [7].

The integration of the elements of an appropriate environment with the components of the IWD further enriches the value of the learning programme, which in turn could create an atmosphere for reflective learning [8].

6. IMPLICATIONS FOR TEACHING AND LEARNING IN ISD CONTEXT

Some specific implications were derived in the attempt to create an appropriate environment for ISD:

- *Physical resources* Organizing an appropriate venue, learning support (educational media, graphical techniques, off-line material), hardware and software (mind tools and application software) within an appropriate time frame is an essential basis for an effective learning and teaching ISD context.
- *Mind tools* (for example, semantic networks, CMC, programming) and graphical techniques (for example, advanced organisers, historic and emerging organisers, CDFD) help learners to understand ISD concepts and techniques.
- *Human resources* provide an interactive learning and teaching environment through sharing of roles and responsibilities. Teaching and administration tasks should be divided between the teacher, peer-tutors and a teaching assistant. A wider human network should be created in an ISD context including peer-tutors, a senior tutor and a technical assistant.
- *The teacher* should have *instructional and project management skills* encouraging interactions between human resources. In addition, the teacher should possess *positive affective characteristics, multiple roles and competences in an ISD context*.
- *Financial resources* Several financial matters exist within an ISD context. Only through the accommodation of the teacher's activities (which deal with financial matters) within the IWD and the division of the activities between assistants could help teacher to concentrate on individual and cognitive instruction.
- *Pre-defined set of instructional strategies, AC, RS and PA* range of pre-defined teacher activities based on both behavioural and constructivist learning as well as teaching principles empower the teacher to create an appropriate climate for teaching ISD.
- *Pre-defined set of learner tasks and activities* becomes a prerequisite for creativity, promoting active learning and learners-centred learning.
- *Multi-method learning experience* The nature of an

destructing other learners, frustrated, turning pages and telling that they see only fragments... I felt that the columnar data flow diagram also raised their self-confidence in system design and helped them to visualize the intended system".

The teacher observed that learners were not easily distracted in the computer lab. Available physical resources supported learners during the implementation of the IWD. They were moving around the groups in the need for explanations and demonstrations of ISD techniques. They were also sitting in pairs, talking loudly while drawing the sketches, exchanging magazines, documents, books and other learning support material.

Learners, however, commented in the focus group interview regarding the allocated time: "We need more formal time ... we spend a lot of time on first two stages...we had time to think about the problem and investigate...".

Learners commented in their journals: "There is little time left for us to complete work...".

(f) Human resources helped learners to extend their knowledge and understanding of ISD procedures

Learners noted in the focus group interview that: "only in class there was somebody, right Maria was there, but when we met up on our own...we need more guidance...".

Learners further commented, "... after having done ...your research ... then your decision-making session will be based on this which option do I use...on the results of reflective thinking...you do the research and then you do the decision-making. You decide on what you going to do, speak to the members of your group and you come up with something".

Notes written in journals revealed that other learners helped each other with ISD tasks and activities: "George helped me"...we helped each other...".

Observation notes revealed: "...they often called an assistant [a teaching and/or technical assistant] to explain a procedure ... or when they experienced a problem (for example with mind tools, Windows, an application) ...".

From the results, and as an answer to research question 1, the elements of an appropriate environment for ISD are allocated within physical, human and financial resources (see par 2.1).

Elements of physical resources with appropriate interaction between human resources should be planned and managed within an appropriate time unit to avoid learners' comments such as "you see we were under pressure with time, we didn't have time to do much, we only had one class a week...".

Interaction between human resources (teacher, assistants and peer-tutors) are crucial not only for knowledge sharing but for the promotion of critical and specific outcomes [27,10]. In the complex learning environment such as ISD, exchange of roles, close monitoring and assessment are expected tasks of human resources.

The help provided by a teaching assistant with regard to administrative burden from the teacher, which lead greater focus on the facilitation of technological problem solving.

The findings indicate that to cater for the elements of an ISD environment learners were guided through AC, RS, PI and a set of pre-defined learner tasks and activities and teacher activities

- appropriate environment for ISD reflects a variety of learning approaches (for example, situated and experiential learning) as learners extend their knowledge and skills through the exposure to real life situations beyond the actual project-based classroom.
- In this paper we present empirical evidence indicating that our efforts have been successful in promoting appropriate environment for understanding information system design. The instructional programme may serve as orientation for learners and the teacher in the ISD context.
- Although this work is presented in the context of an undergraduate web design course, we note that the effort also can be used to enhance understanding of information system design in a corporate environment
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