The application of logical tools in a project-based classroom

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Abstract. *The paper explains how students can use the columnar data flow diagrams and the inference tree to improve their logical thinking, and therefore contribute to better systems analysis and design outputs. Furthermore, the paper explains that these tools are better utilised if they are integrated within the Instructional Web Design Programme (IWDP).*

The logical tools were tested empirically in a project-based classroom at an institution of higher education. The research was based on a qualitative, action-research approach.

The most important findings were: Logical tools set a basis for creating an effective climate for systems analysis and design; the use of inference trees improved detection and correction of reasoning errors.

Keywords. Columnar data flow diagram, inference tree, argument, reasoning errors, logical tools.

Introduction

The need for innovative tools for systems analysis and design has become a widely talked-of-phenomenon in different Information Systems environments [8, 20]. Students in Information Systems design environment draw a data flow diagram by placing components in a random and hierarchical fashion which result in difficulties in reading and checking of diagrams. This in turn influences a fragmented knowledge, low motivational and creative involvement of students' in system design tasks [15].

Mende [19,20,21] suggested that a data flow diagram could be drawn so that components with similar functions would appear in the same column. The author proposed the well thought-out tool the columnar data flow diagram (CDFD) as the reader can visually assess the *power* of the system. The designer of a *data flow diagram* should group like with like … if the components of the diagram were placed randomly, readers would have difficulty finding what they are looking for [8, 19, 29, 16, 28].

Students as systems analysts and designers often write descriptive reports and sometimes they need to write complex reports on business analysis issues. These reports contain different kinds of reasoning errors [22, 23]. Writers very seldom use the keywords such as 'so' or 'therefore' or they use these keywords in a wrong way [24]. The reports are used as a basis for the project releases discussions. So, students need skills in logical thinking expressed in their ability to create clear arguments and connect interrelated components into a 'working system'.

The vast majority of available literature does not addresses adequate logical tools to help students to write reports and construct complex arguments [15]. A complex or expository argument is a system of inferences between core ideas. Mende (2006) proposed an inference tree as a tool to detect logical errors and to enhance arguments construction.

Although the conceptual rationale suggests that these tools (CDFD and inference tree) should be very widely applicable [24] too few examples are given to provide conclusive evidence with regard to their motivational and cognitive applicability in a project-based classroom [15].

The present paper now explains how students in a project-based classroom can use the CDFD and the inference tree to improve their cognitive, motivational and system design skills, and therefore contribute to better systems analysis and design outputs [32, 33, 20, 24, 19]. Furthermore, the paper explains that these tools could be better utilised if they are integrated within an instructional system, the Instructional Web Design Programme (IWDP).

Founded on above discussions the following research questions have been addressed in this paper:

1. *How does the construction of a CDFD influence students' cognitive, motivational and system design skills?*
2. *Why is inference tree the appropriate tool for systems analysis and design?*

Framework for the application of logical tools in a project-based classroom

Columnar data flow diagram (CDFD)

An information system can be represented in a columnar form (See Fig 1).

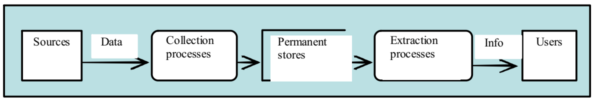

Figure 1: Typical columnar structure of an information system

*S*ince people normally read from left to right, the flows between the groups should be from left to right [19, 15]. So the columns should be drawn in sequence from sources through data, collection, stores, extraction and information to users. Therefore, the structural tool (See Fig 1) now predicts that designers can draw the top-level DFD of many information systems in seven columns.

The CDFD has at least four advantages [19]:

1. If a reader is trying to understand individual components of the system, then the column position of each component immediately identifies the function of that component.
2. If a reader is looking for a particular kind of component, say an inflow or a collection process, then he or she can quickly find it by searching the relevant column.
3. If a reader needs an overview of the system's information outflows and data inflows, then he or she can simply scan the data and information columns.
4. Most importantly, a reader can easily assess the *power* of the information system [19].

Boden (1990) suggests that *vision* is the most powerful human sense, having evolved to notice spatial relations such as connectedness, juxtaposition and gaps'. Skills of visualising are necessary for learning technological processes [10]. A columnar data flow diagram is particularly useful for detecting *gaps* – i.e. design omissions in the pattern of flow from sources and data through collection, stores, extraction to information and users [19].

Practice in a project-based classroom indicates that many gaps exist during complex arguments construction leading to unclear business requirements specifications and poor systems outputs. For that purpose students need a tool which isolates the core ideas from the peripherals in each paragraph and emphasizes the inferences between core ideas. One such tool is the inference tree [22, 23].

An expository argument

An example of an expository argument appears in box 1, where a short argument aims to convince writers that they should use inference trees. The argument spreads over 9 paragraphs, whose core ideas are italicised, and it involves three inferences.

Box 1. An expository argument [24]

	An expository argument
1.	In an expository report, *inferences may have errors of* relevance that cast doubt on the conclusions.
2.	The *inferences may* also *have mismatch errors* that cast doubt on the conclusion.
3.	**So** *an argument may have effectiveness errors* that cast doubt on the conclusion.
4.	Furthermore, some *inferences may be overloaded*, so that the reader cannot easily understand them.
5.	*Inferences may* also *be belated*, so that the reader may have forgotten the inputs by the time he or she reaches the outputs.
6.	**So** *an argument may have efficiency errors* that make it unnecessarily difficult to understand.
7.	A reader rejects a report that has effectiveness errors, and soon stops reading a report that has efficiency errors. **So** *writers should avoid these errors.*
8.	*Inference trees can help writers avoid these errors.* The omission error is easy to detect because inferences usually require two or more inputs.
9.	**Therefore** *writers should draw inference trees.*

The three inferences establish inter-paragraph connections:

- the first inference inputs the cores of paragraphs 1 and 2, and outputs the core of paragraph 3
- the second inference inputs the cores of paragraphs 4 and 5, and outputs the core of 6
- the third inputs the cores of 3, 6, 7and 8, and outputs the core of 9.

Inference tree

Expository arguments are not easy to devise. The main reason is that the human short-term memory can only accommodate 7±2 ideas (Miller's law) [3]. Thus they cannot clearly see how all the core ideas hang together leading to reasoning errors occurring easily [24, 11]. To avoid those errors, writers ought to pay careful attention to the system of core ideas and inferences. For that purpose they need a tool which isolates the core ideas from the peripherals in each paragraph and emphasizes the inferences between core ideas. One such tool is the *inference tree* [22, 23].

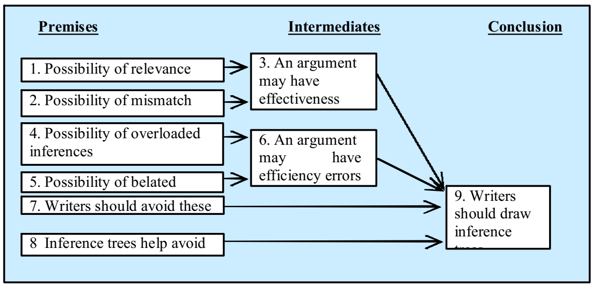

Figure 2: Inference tree of Box 1 [24]

The core ideas are grouped into three classes, each in a different column of the diagram:

- *Premises* are core ideas in the left-hand column: they are not inferred from other core ideas of the argument, but other core ideas are inferred from them.
- *Intermediates* are core ideas in the middle column: they are inferred from other core ideas and other core ideas are inferred from them.
- *The conclusion* is the core idea in the right-hand column: it is inferred from other core ideas, but no other core idea is inferred from it [22, 24].

So an expository argument is a tree of inferences from premises through intermediates to the conclusion. When writers draw an inference tree of an expository argument, they may find many different kinds of reasoning errors: errors of relevance, missing the point, invalid inference, inadequate inference, mismatch, begging the question, circular reasoning, hasty generalisation, overloaded inference, irrelevance, redundancy, omitted inference, belated inference, premature inference, incoherence and inconclusiveness [22, 24].

At the broadest level of classification there are effectiveness errors and efficiency errors:

- *Effectiveness errors* cast doubt on the chain of reasoning from premises through intermediates to the conclusion, resulting in a reader losing confidence in the conclusion.
- *Efficiency* errors create unnecessary difficulties in understanding the chain of reasoning, so that a reader would waste time reading the report [24].

The logical tools (CDFD and inference tree) could be useful to visually depict procedural knowledge pathways and to extend conceptual and procedural knowledge in general [18, 15]. To explore the influence of the logical tools on students' cognition and motivation as well as understanding of systems design processes, an Outcomes-Based (OBE) instructional web design programme (IWDP) was designed and implemented in the project-based classroom.

The instructional web design programme (IWDP)

The development of the IWDP was based on the three pillars of the theoretical framework: mind tools; higher-order thinking; learning theories, instructional models and strategies [30, 15].
The following components of the IWDP have been identified [15]: Theme; Critical and Specific Outcomes; Range Statements, Assessment criteria; Performance Indicators; The stages of the technological process: (Design brief; Investigation; Proposal; Initial ideas; Research; Development; Planning; Realisation/Making; Testing, Evaluation and Improvement); Students' tasks (case study, resource and capability tasks); Students' on and off-line activities; Facilitator's activities (Instructional strategies), Notional time [1, 2, 15, 26]. It was envisaged that the application of logical tools within this organised instructional environment will promote the appropriate climate for systems analysis and design.

Research design

Research approach

This research can be described as a qualitative, evaluative case study seeing that the learning experience of students' and the teaching experience of the facilitator is being investigated in relation to a specific event in a bounded context [9, 35, 25]. The qualitative approach was adopted for this study, as it is particularly suitable for studying phenomena in which little previous research has been conducted [31, 25]. Multiple methods of data gathering and analysis were used to achieve the highest measure of reliability possible within a given method.

In this study action research was also applied to simultaneously create and investigate changes with the use of logical tools in the project-based classroom. The urgency of improving outcomes such as analysis and design skills during the systems analysis and design tasks necessitates an activist research paradigm [4].

Profile of the students, intervention and setting

In this study seventeen students from mixed cultural groups were identified. They were enrolled for the Diploma in Computer Studies at a tertiary institution in South Africa. The students' were grouped into five teams, with three to four students in a group. Participants presented a purposive convenient sample as they were readily available and inexpensive to this study [9].

The researcher of this study coordinated the design and development of web projects in duration of one semester at a tertiary institution. Students had to submit five deliverables (project proposal, high-level analysis, detailed analysis and design, prototype and a final system). The instruction was embedded within the IWDP highlighting the use of the logical tools.

Data collecting methods and analysis of data

The primary data was collected by means of a focus group interview with students and one individual interview with the facilitator. Informal discussion-type interviews yielded data that were easy to align with observation data. The interviews and observations were conducted to explore and identify the core aspects relevant to the use of logical tools.

The systems analysis and design processes were observed in formal and informal observation sessions. The researcher was present in different team meetings, so as to observe, record discussions and events. Next, all available artefacts produced were utilized for analysis. These included documentation/reports as outcomes for five deliverables, agendas, reports, design documents and so forth.

Analysis of data consisted of examining, finding patterns, themes and constructing categories [35, 25]. A constant comparative method was applied which include comparison of data within interviews and between interviews [25]. Necessary preparations were performed to improve essential competence of the researcher in the field, which included the clarification of biases and assumptions [14, 9].

This study is characterized by the use of two different data resources, the facilitator and students' and multiple data gathering methods. The peer examination, the statement of the researcher's biases, and a rich, thick description of the phenomenon under study contributed to the reliability and validity of this research [17, 9, 35, 25].

Findings

The four categories emerged from the interviews, observations and document analysis:

1. *The use of the columnar data flow diagrams simplified the overall assessment of the system components, empowering the students' motivational, visual and cognitive skills*
2. *Time and effort in drawing, checking and reading CDFD was optimised, minimising memory overload and enhancing students' system design skills*
3. *The use of a variety of inference trees improved detection and correction of reasoning errors in written reports*
4. *Inference tree minimized logical fallacies and enhanced transferring logical skills to face-to-face environments.*

Findings regarding students' and the facilitator's experience of the CDFD

The evidence related to the students and the facilitator's experiences of CDFD are presented in the following paragraphs.

1. The use of the columnar data flow diagrams simplified the overall assessment of the system components, empowering the students' motivational, visual and cognitive skills

The following comments were recorded during the focus group interview with students: "*...The columnar style of data flow diagrams is easier to understand because I know exactly where to go…input, storage and output is easy to detect…It is interesting…"*

Another student commented: "*I can visualize all components…the standard data flow diagram is confusing ... it is easy to count the number of inflow arrows and the number of outflow arrows in columnar form... I can see the whole system"*

The facilitator made the comments in the observational protocol: "*Students were guided through the subsequent self-reflective questions:*

- *Who is the user?*
- *What information does the user need?*
- *What extraction process is necessary to produce the information?*
- *From which permanent store(s) should the extraction process obtain data?*
- *What collection process is necessary to get data into each permanent store?*
- *What data are available for collection?*
- *Who supplies the data?*

Observational notes indicated that the use of CDFD empowered students' visual, motivational and cognitive skills, as "*they were attentive, intuitive, focused on tasks and reasoning activities, thinking reflectively and clearly applying thinking at appropriate level of complexity… They reported improved vision of the whole system…"*

2. Time and effort in drawing, checking and reading CDFD was optimised, minimising memory overload and enhancing students' system design skills

Students expressed their opinions commenting that "*...the columnar form is clear ...this is easy to read, link, to check… one can draw all links on one piece of paper..."*

Another student added: *"There is only one side to start from…I can follow the path ...I think it is easy to predict outputs, we do not need to remember many paths scattered around ... I don't need to remember many details…"*

Observational notes indicated that during the Requirements Analysis phase students drew the columnar diagrams which helped them to control memory overload: "the c*ommunication of requirements was difficult task ... too many details and errors…After drawing of the columnar diagrams errors decreased…"*

"The facilitator commented further:"*… Students found omissions in a form of gaps in the pattern of flow with little effort and time…they were happy drawing CDFD only for higher level design ...they were getting tired if additional* *diagrams have to be drawn…They noted detailed relations between components…"*

Furthermore observational protocol revealed: " *Students could find and eliminate errors without being lost…in checking a CDFD, students' detected gaps in the data flow from left to right looking in the direction of arrows. In reading CDFD, students' recognized the function of each component, whether it is a source of data, or an inflow of data into the system, or a process that collects inflowing data. When they searched errors they looked in the relevant column instead of searching the entire diagram…." They often compared the number of information outflow arrows with the number of data inflow arrows*."

Students' commented in the focus group interview *"I can detect links in documents … I get tired reading too many ideas scattered across documents …now it is easier to correct errors with [inference] tree… …it is time consuming to draw tree, but only at the beginning… I can think deeper…"* Another student added*: …"now I know how to write … I know how to present ideas and connect ideas …so I can convince my team members… my conclusions make sense..."*

Findings regarding students' and the facilitator's experience of inference tree

Evidence related to the students and the facilitator's experiences of inference tree has been described in the following paragraphs.

3. *The use of a variety of inference trees improved detection and correction of reasoning errors in written reports*

Students' commented in the focus group interview *"I can detect links in documents … I get tired reading too many ideas scattered across documents …now it is easier to correct errors with [inference] tree… …it is time consuming to draw tree, but only at the beginning… I can think deeper…"* Another student added*: …"now I know how to write arguments … I know how to present ideas and connect ideas …so I can convince my team members… my conclusions make sense..."*

Observational protocol revealed: Students found errors of irrelevance as "*…they examined all inference outputs and asked questions thinking loudly whether outputs were true if the inputs are true…"*

They found errors in missing the point as premises and intermediates didn't imply the stated conclusion, but instead implied a completely different conclusion…"

Observational notes further revealed: *"Students tried to detect reasoning errors in the inferences that link the core ideas of the various paragraphs simply by reading the report….They were lost, frustrated and simply left detecting and correcting errors. Perhaps their memory was overloaded …through practice they learnt how to outline an argument using inference trees…"*

The facilitator noted in the observational protocol: "*It was impossible in the allocated time to train students' to detect different types of reasoning errors…"*

Students commented on easier detection of logical links and elements in a system "*…I don't need to remember many details… …"*

4. *Inference tree minimized logical fallacies and enhanced transferring logical skills to face-to-face environments*

The facilitator's comments indicated that "*…Discussions and brainstorming sessions were true reflections of the students' logical processes. If they detected and corrected errors in documents/reports then logic transfer was evident in discussions. For example the use of words, so, thus, therefore were reflected in the face-to-face communications..:"*

Project documentation and reports handed in after the construction of the inference trees indicated clear argument construction, one core idea in a paragraph; unambiguous connection of core ideas across paragraphs and understandable conclusions. Using of words 'so, therefore, thus' was regular and justified in the text.

Observation notes indicated that "*the use of the inference tree helped the facilitator in guiding system analysis and design tasks. The transfer of logical skills from written to face-to-face communication was also evident in a form of expressing logical links correctly, i.e, using words 'so,thus,therefore'"*

Discussion

Findings indicate that the columnar tool helped the students to save the time in reading, drawing, and checking a system flowchart [13, 19]. When students drew a system flowchart they could gain many advantages through the engagement of their cognitive and motivational power [15]. This was possible as the conceptual rationale [19] provided a basis for the use of the columnar tool in the project-based classroom. In addition, the IWDP with its innovative structure and organized instruction supported the application of the columnar tool lthrough students' tasks and activities.

Findings indicated that students visually assessed the *power* of the system by comparing the number of data inflows with information outflows. In this way they were motivated to continue with system design as memory overload was minimized releasing their cognitive power. The CDFD seemed to assist students with a clear picture of the intended information system, following the rules of data flow diagramming [34]. Therefore, the columnar method facilitated visual, motivational and cognitive skills providing simplified overall assessment of the information system *(as an answer to research question one).*

If designers take the trouble to draw an inference tree at the preliminary outline-design stage of report this effort may well pay off later, as they will not waste valuable time correcting far-reaching reasoning errors [24]. As findings specified, when students tried to detect reasoning errors in the inferences that link the core ideas of the various paragraphs simply by reading the reports or documents they were prevented due to human limited information processing capacities. Findings indicate that training students how to use a variety of inference trees during system analysis helped them to detect, correct and even prevent logical errors. When students were exposed to different types of logic in a variety of inference trees in a written form they were able to transfer those skill to face-to-face communication environment, for instance discussions groups, release meetings etc *(as an answer to research question two).*

The columnar tool and Inference tree help to expand a student's self-regulation system [5] as it provide self structured feed-back and feed forward system not depending on an external human intervention. Therefore it empowers students' cognitive skills expanding their self-regulation system. Findings also indicated time constraints and a cognitive strain in drawing columnar diagrams and inference trees. Perhaps, there was a need for a sustained practice in a sufficient time frame.

Conclusions

The following conclusions and implications for systems analysis and design contexts can be drawn from this inquiry: In the attempt to enhance motivation, thinking and system design skills, appropriate attention should be given to the relevant conceptual framework on the logical tools (the columnar tool and inference tree) [19, 20, 21, 22, 23] and the appropriate application of these tools within an organised instruction in the project classroom.

The logical tools support a structured approach in systems analysis and design. These tools resemble human information processing thus minimizing memory overload and increasing the quality of logical thinking. Furthermore, logical tools enhance students' argument construction skills, providing a transfer of those skills into different learning environments.

The use of CDFD could provide a strategic overview of the intended system, which fosters deep learning. Inference tree should be used durin systems design tasks, particularly in writing reports/documents which indirectly improves logical thinking of systems designers and decrease logical based errors.

The CDFD may also be useful in object-oriented design, which tends to abandon these tools [20, 21, 27, 28]. So, when designers draw for example, use cases in object-oriented design, the columnar rules can be applied. Designing complex information systems with many use cases in a hierarchical form is confusing due to the nature of human limited information processing [12, 6].

This paper was an attempt to investigate the applicability of logical tools in an information systems design context. The advantage was also that these tools were applied in an organized manner with the support of the IWDP in the innovative learning and instructional context.

There is a need to investigate the use of these tools in different Information Systems contexts in order to provide conclusive evidence of wide applicability.

References

[1] Ankiewicz P, De Swardt AE & Stark H: **Principles, methods and techniques of Technology Education I,** Rand Afrikaans University, RAUTEC, Johannesburg, South Africa, 2000.

[2] Ankiewicz P & De Swardt AE: **Teaching strategies for grade facilitators: Applying the principles of outcomes education.** Rand Afrikaans University, RAUTEC, Johannesburg, South Africa, 2001

[3] Baddeley A: **Your memory – a user's guide,** Middlesex: Penguin, Harmondsworth, USA,1993.

[4] Baskerville RL & Wood-Harper AT: **A critical perspective on action research as a method for information system research,** Journal of Information Technology, 1996, 11, pp.235-246.

[5] Bedny GZ & Seglin MH: **Individual features of personality in the former soviet union**. Journal of Research in Personality, 33, 1999, pp.546–563.

[6] Blaha M & Premerlani W: **Object-oriented modelling and design for database applications,** Prentice-Hall, Englewood Cliffs, New Jersey,1998.

[7] Boden M: **The Creative Mind,** Weidenfeld & Nicolson, London, UK, 1990.

[8] Budgen D: **Software Design,** Addison Wesley, Massachusetts, USA,1994.

[9] Creswell JW: **Research design: qualitative & quantitative approaches**, Sage publications, Thousand Oaks, USA, 1994.

[10] Fogarty R & McTighe J: **Educating teachers for higher order thinking: The three story intellect,** Theory into Practice, 32(3), 1993, pp.161-169.

[11] Govier T: **A Practical Study of Argument,** Wadsworth, Belmont, California, USA, 1997.

[12] Graham I: **Object-oriented methods,** Addison-Wesley, New York, USA,1994.

[13] Hahn J & Kim J: **Why are some diagrams easier to work with? Effects of diagrammatic representation on the cognitive integration process of systems analysis and design,** ACM Transactions on Computer-Human Interaction, (6)3, 1999, pp.181-213.

[14] LeCompte MD, Preissle J & Renata T: **Ethnography and qualitative design in education research,** Academic Press, San Diego, USA, 1993.

[15] Jakovljevic M: **An instructional model in teaching complex thinking through web page design**, (Dissertation). Rand Afrikaans University. Johannesburg, South Africa, 2002.

[16] Kabeli J & Shoval P: **Foom: functional and object-oriented methodology: An integrated technique,** Journal of Database Management, 12, 2001, pp.15.

[17] Kerlinger FN: **Foundations of behavioural research,** Harcourt Brace College Publishers, Orlando, Florida, USA,1992.

[18] McCormick R: **Conceptual and procedural knowledge,** International Journal of Technology and Design Education, 7, 1997, pp.141-159.

[19] Mende J: **Three packaging rules for information system design**, Quaestiones Informaticae, (5)3, 1987, pp.32-35.

[20] Mende J: **A classification of partitioning rules for information system design,** Quaestiones Informaticae, (6)2, 1988, pp.63-66.

[21] Mende J & Mohamed F: **Data flow diagrams with functional columns**, Paper presented at the Information Systems Research Seminars, University of the Witwatersrand, Johannesburg, 1999.

[22] Mende J: **Two logic tools for expository reports,** Paper presented at the Teaching & Learning Symposium, University of the Witwatersrand, Johannesburg, 2005a.

[23] Mende J: **Modular inference trees for expository reports,** Informing Science, (8), 2005b, pp.173-187.

[24] Mende J: **Using inference trees to detect reasoning errors in expository reports,** Paper presented at the Teaching & Learning Symposium, University of the Witwatersrand, Johannesburg, 2006.

[25] Merriam SB: **Qualitative research and case study applications in education,** Jossey-Bass, San Francisco, USA, 1998.

[26] Reddy K, Ankiewicz P & De Swardt AE: **The essential features of technology education: a conceptual framework for the development of OBE (outcomes based education) related programmes in technology education**. International Journal of Technology and Design Education, 2003, 13, pp.27-45.

[27] Shoval P & Kabeli J: **Functional and object-oriented analysis and design of information systems: An integrated methodology,** Journal of Database Management, 12, 2001, pp.15.

[28] Shoval P & Sadan F: **Functional analysis and object-oriented design: A hybrid methodology**, Available at www: http:/hsb.Baylor.edu/ramsower/ais.ac.96/papers/shoval.htm, Accessed: March 2002.

[29] Shoval P: **An integrated methodology for functional analysis, process design and database design,** Information Systems, (16)1, 1991, pp.49-64.

[30] Throwbridge J & Wadersee JH: **History and philosophy of science and the preparation for constructivist teaching: The case of particle theory,** In J.J. Mintzes JH Wadersee & Novak JD,1998, Teaching science for understanding. California: Academic Press, pp.165-192.

[31] Walsham G: **Interpretive case studies in IS research: nature and method**, European Journal of Information Systems, 4 (2), 1995, pp.73-83.

[32] Waters SJ: **Introduction to computer systems design,** NCC Publications, Manchester, USA, 1974.

[33] Weinberg V: **Structured analysis**, Prentice-Hall Englewood Cliffs, New Jersey, USA, 1980.

[34] Whitten JL & Bentley LD: **Systems analysis and design methods,** Richard D. Irwin, Burr Ridge, Illinois, USA, 1998.

[35] Yin RK: **Case study research: Design and methods**, Sage Publications, Thousand Oaks, California, 1994