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Application of Soft Systems Methodology for Computer Module Evaluation for Teaching Computer Technology in Girl's Secondary Schools in Al Qassim Saudi Arabia

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Soft Systems Technology Evaluates Computer Teaching in Girl's School, Saudi Arabia.

Original Research Article

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Abstract: Presently computer technology is becoming an important education tool especially in girl's schools about the use of computer technology. Therefore, the main objectives of this study was to introduce different types of computer and information technology knowledge related to student's life and society requirements. The population for this study was a group of people involved in the module including both the teachers and students from two secondary schools in Al- Qassim. Personnel interview was considered as the best method for the study from the researcher's perspective. A conceptual model was developed to evaluate the use of Soft Systems Methodology (SSM) for the improvement of teaching computer technology in girls' secondary schools. Questionnaire was designed based on the Likert Scale for the respondents to sate their level of agreement on the scale of five items [strongly agree, agree, neutral, disagree and strongly disagree with a scale ranging from 1 (strongly disagree) to 4 (strongly agree). The implementation of the Soft Systems Methodology was illustrated by stages, which included the development of a rich picture, root definitions, conceptual models and comparison with the real world. The application of SSM achieved some of the study objectives pertaining to computer teaching technology in girl's secondary school encountered by many obstacles. The achievement of SSM application was presented in the rich picture which seemed helpful especially in presenting the conflict between the students and the teacher's demands keeping in view the limitations of the program for better understanding of the situation. The induction of computer teaching technology proved useful in enhancing the student's skill about the benefits of computer tools in learning at schools. The suggested system was found useful for updating the use of SSM by applying the computer module in teaching computer technology in girl's secondary schools in Al-Qaseem, Saudi Arabia. Because it is comprehensive and would fully examine the application of SSM methodology. This study recommended the application of SSM in schools context but within the context of individuals' conflict situation. Application and use of computer teaching technology is an important education tool especially in girl's schools about the use of computer tools and software for improving learning skills about different aspects of life. This study recommended the induction of computer teaching technology for enhancing the student's skill about the benefits of computer tools for learning and understanding different aspects of life at school levels.

Keywords: Soft system methodology, computer technology, girl's education, advantages, limitations, student's response.

INTRODUCTION

Presently, major developments of information technology are showing significant impact on every aspect of life. Therefore, the awareness of information technology and its use in the workplace are highly important due to rapid growth of computer and communication technologies in power and expanding their scope from conventional to pervasive computing technologies.

As a consequence of the rapid development of technologies, many developed countries have improved their quality of teaching and learning thus offering the students an education that is appropriate to the requirements of modern life. Education relating to the development of knowledge and skills in computer technology seems to create a productive and sustainable society to work in an increasingly competitive employment market. Comper *et al*., [1] reported that all the students want to take full advantage from high

quality computer technology education even without adopting in their future career.

Recently, many of the developing countries tried to follow the developed countries' education systems by employing computers in the educational process. Among these, Saudi Arabia is one of the developing countries where computer literacy officially became a part of education for boys aged between 14-16 years in 1990.

Since computer literacy is relatively a new subject especially for girls' secondary schools in Saudi Arabia , the researcher was determined to evaluate the current state of the computer curriculum in girls' secondary schools by using Checkland's Soft Systems Methodology which will be referred to as SSM in this study. The main aim of this study was to investigate the use of SSM as an assistant tool for the evaluation and improvement of the computer curriculum both for students and teachers and highlights the conflicting expectations and views to achieve a comprehensive appreciation of the situation under study. Because SSM not only grants a clear understanding of the change required to overcome some obstacles and problems but also the change is culturally feasible. This implies that stakeholders will be inclined to participate in the proposal and the process of the change [2]. Patel [3] stated that "*the methodology is unique because it enables the analyst to embark on a process of learning about the real world situation being investigated, while simultaneously seeking to improve it by analysing the situation and suggesting recommendations for further action to improve the problem situation*."

Use of SSM for the evaluation of computer education

The main reasons for choosing the SSM as a tool for the evaluation of the module are to have a better appreciation about the current status of the computer curriculum being taught in girls' secondary schools, to find the obstacles and difficulties regarding the content, objectives, achievements and learning environments and methodologies, and to generate deep insight and to introduce further exploration and modifications suitable for the current as well as future needs.

In early 1980s, the Ministry of Education tried to provide students with a strong background about the art of computer literacy and expand their attitude toward information technology. Therefore, in 1985, a variety of computer subjects were introduced into some of the boys' secondary schools (pupils aged 14-16) as a trial curriculum without counting their grades in the final total score [4]. The contents and the design of the module were developed by highly-qualified lecturers from different universities in the country. However, the Ministry of Education decided to include computer teaching as an official curriculum in all boys' secondary schools during the academic year 1990-1991, [5]. However, the private schools had already included un-evaluated computer subjects from elementary level (pupils aged 6-11) as an element of attraction and to provide pupils a strong foundation in computer skills from at an early age [6]. The General Presidency for Girls' Education was established in 1959 to create awareness about computer technology and its influence on all aspects of contemporary life especially for girl's education. The Presidency took the initiative to develop strategic plans to introduce this technology in the girls' educational sector along with the male students [7].

The introduction of a computer curriculum into girls' secondary schools was planned for teaching from the second year for both the science and arts paths. This was initially implemented only in twenty nine secondary schools from four educational zones namle Riyadh, Mecca, Jeddah and Dammam during the academic year (1998 -1999). In addition, Presidency developed a strategic plan for the introduction of computers in all General Presidency for Girls Education sectors under the chairmanship of the Assistant Undersecretary for Planning and Development, Saudi Arabia named Khalid bin Abdullah Bindheish [8].

A computer curricula authors committee designed three official educational books including the student's computer practical application book, student's computer theoretical book and teacher's book. The committee also established teaching methods suitable to the nature of the computer module. This was followed by teaching computer technology in 29 girls' secondary schools as a trial module during the academic year 1998-1999 without counting grades towards the final total score. The computer module was designed to constitute almost 0.05% of the total modules as shown in Fig.1 based on the findings of Doheash and Albisher [7].

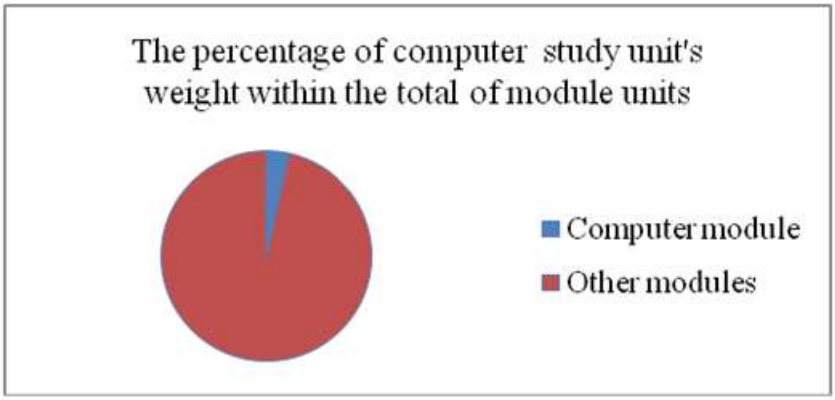

Fig-1: Source: Doheash and Albisher [7].

After successful implementation of computer teaching in 29 girls' secondary schools, the General Presidency for Girls' Education introduced the module to all girls' secondary schools in the country in the academic year 2002-2003 which was approved by the Deputy Minister of Education and implemented in the academic year 2006- 2007 by Haia, Alawad (Director of Curricula of computer Education in Saudi Arabia).

As a result of this, the contents of the computer module for both the second and third levels were modified to develop cohesiveand logically organised curricula having understandable components. In the following academic year (2007-2008), it was decided officially to introduce the computer module for both the second and third levels of girls' secondary education [9]. Accordingly, the computer curricula for all girls' secondary education levels became a compulsory module with its own assessments criteria and teaching methods supported by Haia Alawad, the Director of Curricula Unit in Riyadh educational zone.

Objectives of Computer Module in Girls' Secondary Education

The main objectives of the Secondary Computer Modules based on the guidelines of Ministry of Education, General Directorate for Development of Curricula (2003/2004) (Ministry of Education [10] were to accomplish different types of computer and IT knowledge related to a student's life and society's requirements, efficient use of different computer applications, provision of computer as a research tool for students to discover and obtain new knowledge, increasing the student's interest in computer usage and its applications and, encourage the students to practice the computer learning with and without classes.

Statement of the Problem

The implementation of the strategic plan for introducing the computer literacy to girls' secondary schools took around nine years from 1998 to 2007. During this period, many development processes such as the improvement of the textbooks, laboratories, teaching methods, and teacher training were considered. However, by the academic year 2007-2008, most of the difficulties were overcome and the computer education program became stable and efficient according to Haia Alawad, the Director of Curricula Unit in Riyadh educational zone. Furthermore, the major goal at each educational level involved in this program was to enhance the students' knowledge of computers and improve their attitudes towards them. Therefore, the researcher was interested to discover the current difficulties and obstacles facing the new teaching program of computer technology from both the teachers' and students' perspectives, by using SSM as a tool to facilitate the evaluation. With this in mind, the author tried to address the questions namely the student's views about developing their academic achievement regarding computer technology, ideas of teachers regarding the main deterrents to teaching computer skills in girls' secondary schools and, how to improve and tackle the computer education obstacles?

Research Methodology

The girls' computer education program was initiated in 2007 after nine years of development and planning. Al Qassim city was chosen for fieldwork due to easy access with respect to approval and data gathering process.

The population for this study was a group of people involved in the module, including both the teachers and students, were selected from two secondary schools in Al- Qassim city namely Altalaye and Alfajer schools. In order to conduct the study, interview was considered as the best method to conduct the study from researcher's perspective. Because it will provide inclusive and more accurate information than any other methods according to Martin [11] in applying a tool such as SSM. However, due to difficulty in approaching the participants located at distinct geographical location, it was not possible to carry out this methodology. Therefore, a questionnaire was developed with a combination of closed and open format questions for data collection. The questionnaire was distributed among 60 students including 30 students from each of the two schools with ten students

from each level. In addition to the above method, open format questions were also sent to 4 teachers (two from each school)to discuss and obtain their opinion about the current difficulties in teaching computer technology and using SSM as a tool for dealing with the case. It was also necessary to verify students' opinions about the problems in the computer education process. The questionnaire consisted of three parts such that 1): specific questions to find out its difficulties, 2) to discover the barriers to achieving the module objectives and 3) related to the computer teaching methods and environments.

Analysis of Questionnaire

The questionnaire was translated from English into Arabic for the convenience of the participants for understanding the questions and to express their views clearly. The researcher used a statistical package for Social Scientists (SPSS) for analyzing and computing all the quantitative data. The SSM was the main tool in analyzing and evaluating the overall situation to find the best possible focus on the current problem.

Data collection

In order to ensure proper data collection, approval for data collection was obtained from the General administration of girls' education in Al-Qassim City. The main assumption of this study was that SSM would helpfully reveal some unforeseen obstacles and improve those disagreed decisions that would affect the effectiveness of teaching computer studies in girls' secondary schools in Al Qassim City, Saudi Arabia.

The Soft systems methodology (SSM) was followed to process modeling or problematical human situations to deal with changing complexity and to solve managerial problems to make them more acceptable [12]. According to Capra [13] and O'Connors and McDermott [14] system's thinking deals with a problem or situation by presenting problems as a part of the entire system instead of viewing events or outcomes and developing unwanted problems.

Previously, system development methodologies were developed by the technical and engineering department and focused on systematic approaches without considering the human element as an essential factor including some approaches such as systems analysis, systems synthesis and systems selection [15, 16, 17]. In another study, Delbridge and Fisher [18] reported that the system's concept is merely used as an interrogative device thus allowing discussion and dialogue among those involved in situations without clear agreement on the nature of the problem. Physical and designed systems are not fully considered with 'Soft' Systems due to un-necessary human activities of the individuals of the organization for cooperation [19]. The developed models, in addition to the contentions related to their selection, can be used for the principles of organizational problem-solving via identifying both activity-structure-related contemplation and skills required for the activities [12]. In contrast to other systems engineering techniques, that can be expanded more and more, "SSM attempts to constrain your thinking in order for you to expand your thinking [20].

The SSM is a methodological framework for understanding of interpretations rather than the derivation of a laws or rules that can be generalized for application to all kind of problems. Basically, SSM is a comparison of the world as it is and of models of the world as it might be rather than a prescription according to a set of guidelines by Delbridge and Fisher [18]. Seven stages comprising e the classic SSM inquiry were described by Williams [20] as given in Fig-2.

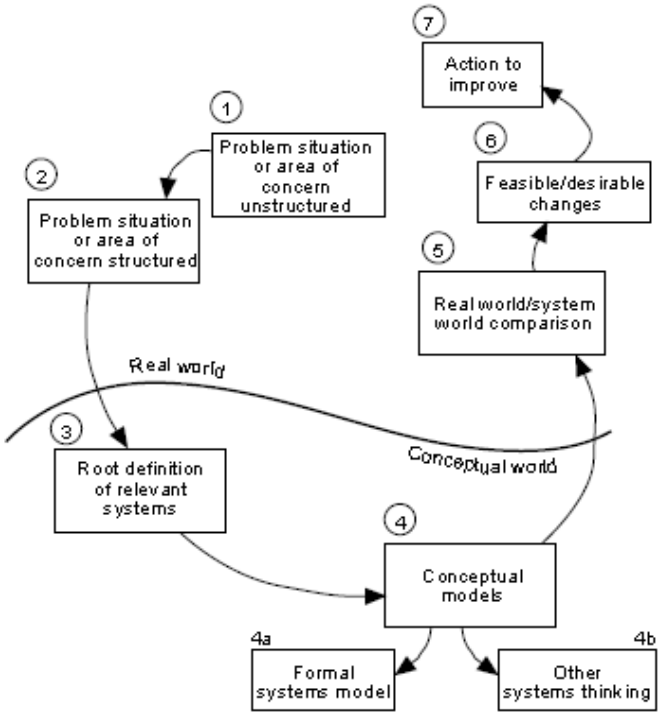

Fig-2: Checkland's seven-stage soft systems methodology.

Stages One and Two: Defining the Situation

Based on the findings of Williams [20], the first step defined the area of concern and evaluated the situation. Once the area of investigation was highlighted, then data, quantitative or qualitative, was collected using a suitable method i.e. surveys, questionnaires, observations, etc. The rich picture facilitated an understanding of the problem including some key elements such as structures, processes, climate, people and maybe some issues and conflicts raised by people [16, 19].

After identifying the relevant human activity systems (HAS), root definitions were constructed which were unique and challenging for the modeling environment [19]. To facilitate this process and to ensure that the root definition is complete, CATWOE was developed by Checkland [21]. The *CATWOE* is a mnemonic of characteristic that stands for customers or clients, actors or agents, transformation, *Weltanschauung*, ownership or owner and environments.

However, this mnemonic was modified by some authorities on critical thinking. The changes included the replacement of the concept Customers (C) with two new concepts namely the Beneficiaries and Victims (B and V), respectively, and as a result the mnemonic has become BATWOVE instead of CATWOE. Chilvers [22] highlighted that the new element can be ideas as well as people. In addition to the advantages of the mnemonic in the formation of the root definition itself, it can be used as a checklist to ensure the comprehensiveness of the root definition, regardless of which mnemonic was used, the former or the latter [20].

Development of the Model

Based on root definitions constructed earlier, a comprehensive conceptual model was developed including all the elements of the CATWOE mnemonic [19]. According to Checkland and Poulter [12], several parameters should be met to validate a conceptual model. The conceptual model consisted off several components 'subsystems' which should be interactive. Also, the interaction of the model with the external environment was analyzed and boundaries between the system and the environment were determined. These steps allowed the evaluation of the conceptual model for stability and determination of the resources.

The developed conceptual model was compared to the real world to gain insights based on this comparison according to Platt and Warwick [19] who stated that *"The conceptual model identifies which activities need to be included in that particular HAS.* However, the modeler should not confuse the model with the reality when comparing a conceptual model to the real world as stated by Patching [23].

The methodologies such as different root definitions, Undertaking different systems-based analyses, Owner analysis, undertaking a social system analysis and conducting a political analysis were

considered to check the feasibility of the model and to underline any interventions based on the findings of Checkland [21].

Applications of Soft Systems Methodology

The SSM was widely accepted ranging from small organizations such as local food producers to large companies such as British Airways [24]. Vast number of applications employ SSM as a front-end to a hard system methodology, as seen in the Structured Systems Analysis and Design Method (SSADM) [24].

Soft Systems methodology in an educational context

The role of Soft System Methodology (SSM) in higher education cannot be overestimated due to its simplicity and usefulness of the outcome [3]. A good example of problems in higher education is that students always want to achieve the highest possible degree classification according to Patel [3]. Teaching and learning methods can be complicated, especially at the higher education level due to significant variation in the teaching and learning approaches conducted at different levels of education [18]. The use of SSM to evaluate and solve problems in a higher education organization was done by Patel [3]. The study revealed unrecognized problems with regard to the teaching and learning process.

Results

Analysis of Questionnaire Data

Two methods for information collection were used to obtain views from both the teachers and the students. The first method used a questionnaire with 25 questions varying from open to closed questions especially designed to elicit the students' views. The other means of gathering data were open discussion with the computer teachersto receive expanded and clarified responses from them seems very helpful when applying SSM. The questionnaire was distributed to 60 students and the discussions were conducted with four teachers. The total number of responded students was 56 which showed a high rate around 93%.

Validity of the questionnaire

The validity of the questionnaire was proved using a validity approach called ‘Face validity’ based on the judgment of experts in the field [25]. This involved submitting the first draft of the questionnaire, along with study objectives and rationales, to a specialist working in the field of computer technology teaching.

Reliability of the questionnaire

The validity and reliability of the questionnaire was conducted using SPSS (Statistical Package for Social Science 15.0), especiallyusing the Cronbach's alpha model recommended for measuring the reliability which is flexible and can calculate the realibility of the whole questionnaire [26].

Tables-2 and 3 shows that the reliability test for the whole questionnaire is clearly "high".

Table-2: The whole questionnaire reliability rate.

Reliability test approach	No of items 20
Cronbach's alpha value	0.987

Table-3: Questionnaire reliability rate for each section.

Reliability test approach	Section 1 Eight items	Section 2 Six items	Section 3 Five items
Cronbach's alpha value	0.962	0.962	0.965

Questionnaire design and findings

The questionnaire design was based on the Likert Scale allowing the respondents to state their level of agreement on a scale of five items (strongly agree, agree, neutral, disagree and strongly disagree). The researcher decided not to give the respondents the “neutral” option since it would end up with uncertain results and the researcher believed that this might affect the application of SSM as it requires clear viewpoints from various stakeholders. The scale points, therefore, ranged from number 1 (strongly disagree) through to 4 (strongly agree). There were two general questions which introduced the students to the specific closed questions. followed by a single question specifically made to measure students’ agreement about teaching computer in school This was followed by eight closed questions relating to the first section, six to the second section, and five to the third section. The survey used three criteria namely Students’ views about computer curriculum design, content and organization. The average score for each item, for each section and for the whole questionnaire were calculated using SPSS 15.0 software particularly by applying the so-called ‘Ordinal Scale of Measurement’ and presented in Tables 4-7.

Table-4: The average score for the first question

Item	Text of the statement	Average score
1	I believe Learning computer technology in school is essential.	**3.46**

Table-5: The average score for section one

	Item	Text of the statement	Average score	General average
Section one	2	Computer module provided the primary knowledge required by students.	**2.75**	**2.56**
	3	The module content was up to date.	**2.42**	
	4	The curriculum was well-designed and planned.	**2.69**	
	5	The module content was cohesive and organized into logical and understandable components.	**2.89**	
	6	Both parts (practical and theoretical) were realistically divided and not weighted retrospectively in one part.	**2.17**	
	7	The quantity of the content was further extended (intensive).	**2.96**	
	8	The content was complicated and difficult.	**2.60**	
	9	The module content was encouraging and interesting.	**2.03**	

Table-6: The average score for section two.

	Item	Text of the statement	Average score	General average
Section two	**10**	I believe I am able to apply what I have learned in this module	**2.78**	**2.56**
	11	I believe I can apply the applications I have learned to my daily life requirements	**2.64**	
	12	After learning this module I believe that my computer skills have improved	**2.46**	
	13	My ability to use the computer as a means of searching and discovering has developed.	**2.73**	
	14	Learning computing at school has enhanced my ability to analyse and evaluate issues	**2.33**	
	15	I believe topics given in this module have positively enhanced my interest in computing	**2.42**	

Table-7: The average score for section three.

	Item	Text of the statement	Average score	General average
Section three	16	Estimated learning time (90 minutes a week) was sufficient.	**2.07**	**1.77**
	17	There were various learning activities that raised interest and motivation.	**1.78**	
	18	Computer laboratory equipped with appropriate facilities that support learning.	**1.42**	
	19	Teaching method followed by computer teacher was effective.	**2.08**	
	20	There was sufficient assistance during the practical applications session.	**1.53**	

Open question results

The answers of the respondents were analyzed by assessing the response of each individual and broken down into components. Then all response components were grouped into categories. The first open question results are shown in Table-8.

Table-8: Students' response to the first open question (statements and the percentage regarding theoretical part of the textbook).

1	*First open question statement*
	What are the aspects of computer textbooks, both theoretical and practical, that hindered you from learning effectively?

	Text of the statement according to students' responses	Number of students	Percentage
Practical part of the module	Most of the practical applications in the practical textbook were explained using an older version of the software.	38	67%
	I found certain topics were presenting very early technological applications: some mentioned DOS, others mentioned BASIC programming language.	24	42%
	I found certain computer terms were unclear and not explained.	10	17%

The Second open question results are shown in Table-9.

Table-9: Students' response to the second open question (statements and the percentage regarding practical part of the textbook).

2	*Second open question statement*
	After you answered section 2 questions (10-11-12-13-14-15) what deterred you from achieving any of them?

	Text of the Statement according to students' response	Number of students	Percentage
Achievement of the module aims	Lack of appropriate facilities. Some mentioned that a number of students shared one computer; some stated that computers were not working most of the time; others mentioned that the teacher did not fix the crashed computers.	39	69%
	Most of the practical applications in the practical textbook were explained by using an older software version, which made it difficult to apply.	35	62%
	Lack of assistance.	31	55%
	Teacher did not explain the lessons properly.	15	26%
	I found some practical applications were not interesting.	12	12%
	It is difficult for me.	5	8%
	I have no personal computer at home to practise what I have learned.	2	3%

The third open question results are shown in Table-10

Table-10: Students' response to the third open question (statements and the percentage).

3	*Third open question statement*
	What aspects regarding the teaching methods and learning environment do you think might enhance your learning and achievement?

	Text of the statement according to students' responses	Number of students	Percentage
Teaching methods and learning environment	Extending the lab work session time would help (90 minutes a week was not enough).	41	73%
	Provide a well-facilitated lab with adequate computer units that accommodate the actual number of students.	37	66%
	Provide assistance during practical applications.	29	51%
	Provide unlimited access to computer lab for students use.	11	19%
	Organise motivating activities.	9	16%
	Eliminate the assessments, as I think it hindered students from learning effectively.	6	3%

Observations

Students' views were analyzed by considering the above results and summarized as below.

Question-1. The results strongly showed that the students considered computer training as valuable. This was unexpected as the computer teachers stated that students were not motivated to learn something new in the field.

- The response of students to questions 2-9 showed that on an average, more than 65% of the students were not happy with the content.
- Around 69% of the students observed that the contents were not explaining up to date topics, applications, information systems and software.
- Around 58% of the students stated that the theoretical part was too intensive. This was confirmed by their teachers (students enjoyed the practical part more than the theoretical).

Questions 10-15, the general average value of 2.56 showed that around 60% of the students were doing well. However, clarification for these questions were clearly expressed in the open question regarding in section 2 which indicated that a high percentage of students were not satisfied and some of them attributed this to the delivery of the module content, which they had already mentioned in the first section, and others to the learning environment which they also stated in the third section. For example: 55% of the students attributed their low achievements due to lack of assistance during the lab work.

Finally, the student's satisfaction with the learning environment, teaching methods and facilities was examined from the response to questions 16-20 and the third open question. The general average of 1.77 indicated a low rate which was attributed to many reasons namely inadequate time for laboratory session according to 69% of the students. Also 62 % of the students blamed the poorly-equipped computer laboratories.

Many of these observations, in addition to discussion with the computer teachers, were represented as a rich picture (stages one and two of SSM in the next chapter), offering a deeper insight with a holistic view of the situation.

Application of SSM

The specific purpose of the researcher in this studywas the application of SSM within the situation of computer education in girls' secondary schools. (Checkland and Poulter [12]. A rich picture was constructed by using the list of observations besides the information gathered after discussion with computer teachers. Secondly, root definitions were developed for each issue derived from the rich picture. Followed by the structure of the conceptual model which was later compared with the real world using Matrix approach.

Rich picture

In this study, construction of a rich picture identified some issues and problems of key importance and were not clear before this stage for the researcher. The rich picture is shown in Fig-3.

From this rich picture a focal point was provided for extra analysis as a number of arguments seemed to be involved, as follows:

There was a clear perception among students and teachers that the content of computer module was not and still is not presenting state-of-the-art topics and applications, and this might negatively affect students' performance and interest toward learning computing. However, in Saudi Arabia, there is an authority responsible for designing, developing and delivering all general education curricula textbooks. These long periods of time mostly did not badly affect majority of modules for other subjects, as most of the curricula by their nature do not require regular updating. In contrast, the computer module does require this, as the programmes, software, applications and related topics are upgraded frequently and changed quickly. So, it is very important to keep students up to date with the latest information and technology required to compete in this vastly changing modern life. Thus, how could the module content be updated regularly on cost effective basis and in a short process time?

There was an issue regarding assistance in class due to poor performance of large number of students due to lack of support from their teacher. This was confirmed by the teachers who claimed that it is not really possible for one teacher to offer individual support to 30 students in a class with duration of only 45 minutes (practical session).

It appears that both the students and teachers disagreed with the session time of 45 minutes as they thought they would have done much better if the class time was longer. Because students always complained about short of time for learning and practising. There was an issue with the computer lab including shortage of computer units and lack of computer maintenance. Having highlighted various key issues, the researcher now started to consider the soft systems method in solving these issues such as developing relevant systems that would deal with these problems.

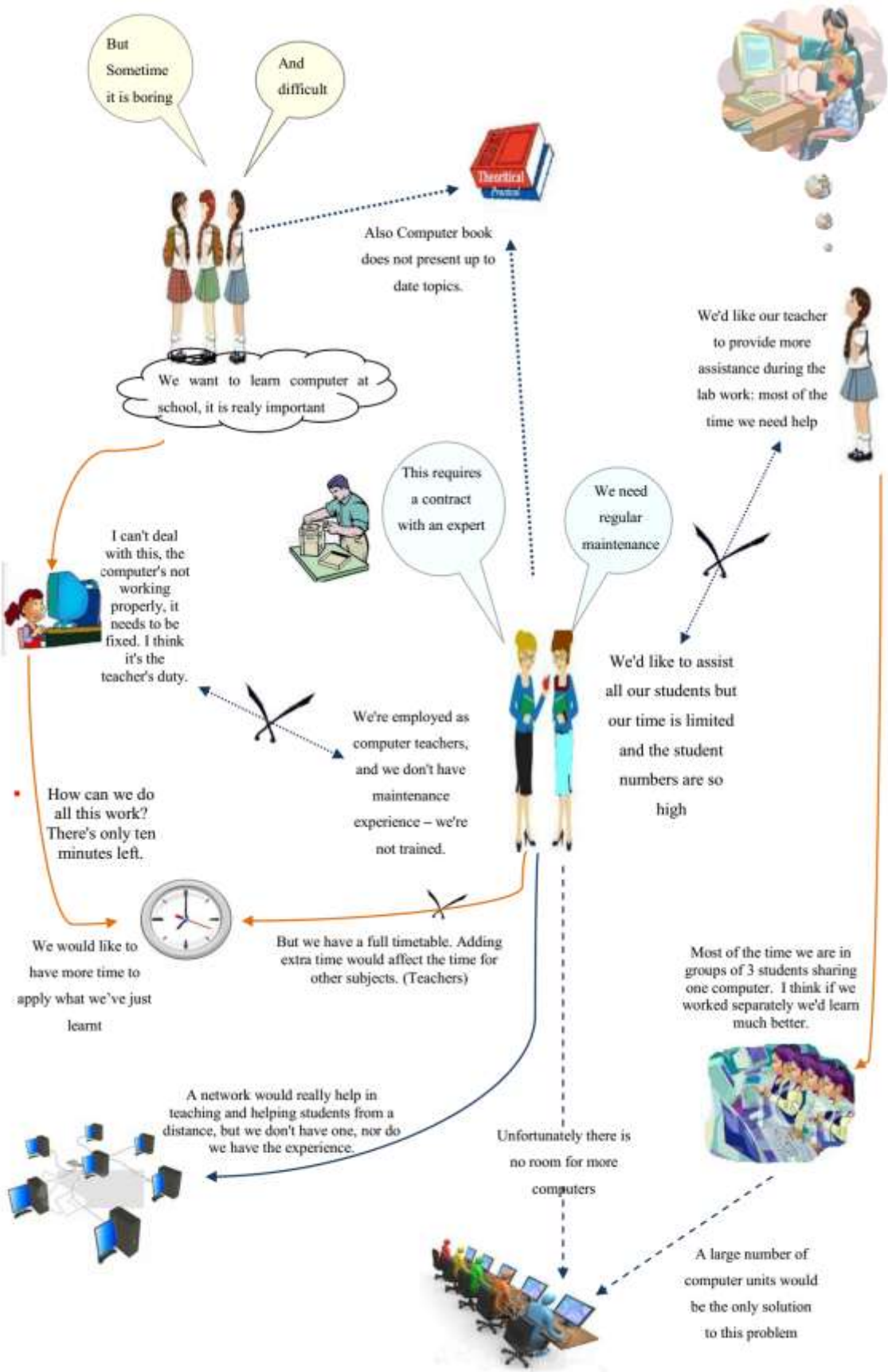

Fig-3: Rich picture of the computer teaching situation

Root Definition

In this stage, besides developing relevant systems and their root definition, a CATWOE was used to make sure that root definitions include the most important elements. In general, primary root definitions, advice and ideas were received from people who were contacted, and the final root definitions were presented.

System 1: A system for updating computer module content regularly on a cost-efficiency basis and with shorter time processes

The primary root definition was sent to the same member of staff with whom the researcher had a discussion and this person replied with a number of notes and suggestions that assisted in modelling the final root definition. The final root definition and a CATWOE related to this system were modelled in Table-11.

Table-11: System 1 Root Definition and CATWOE analysis.

Root Definition (System 1)	
The general administration of the curricula design and development owned and operated a system to supply cost-effective and regularly updated computer materials by: developing regularly updated electronic materials, dividing the materials into scheduled subjects to ease searching, selecting and updating, making it easy to access by computer teachers, sending notification once any aspect of the material was updated. This was in order to broaden students' knowledge of the latest computer technologies that fit rapidly changing modern life.	
C A T W O E	
Elements	**Description**
C	Students and teachers
A	The general administration of the curricula design and development with support of the department of computer curricula.
T	The need to improve student computer education by providing regularly updated computer materials within the budget-→ The output: highly computer skilled students (the need met by producing updatable and affordable materials)
W	The belief that computerising the material is an effective way of producing economically updatable materials.
O	The general administration of the curricula design and development
E	Budget, facilities (computer and internet access), human resources required for regular updating and notification, other physical support.

System 2: provided support, adequate number of computers, and effective use of session time

The limitations encountered by the researcher during building this system were:

- Lack of time to provide adequate assistance for about 30 students
- Secondary school levels timetables are full; therefore extending the session time is a complex issue.
- There is no room for additional units.

Primary Root Definition of System-2

A system owned and operated by girls' secondary schools is to provide required assistance, enough computer units and beneficial use of time during computer sessions. This was achieved as follows:

- The class was divided into two groups, so that one group of students can have a computer theory session while the other group can have the practical session for the first class and then the groups swap over in the second class for the same week.
- The student's computers were connected with teacher's computer (network). This was done to ease the process of supporting and providing an adequate number of computer units to improve the student's performance.

It was observed that students benefitted more by this technique. On the other hand, the computer teachers seemed to be overloaded as he would teach the lesson twice for each class. Briefly, the primary root definition for system 2 was not modified and a CATWOE model related to this system was developed as presented in Table-12.

Table-12: CATWOE analysis for System 2.

C A T W O E (System2)	
Elements	**Description**
C	Students
A	Schools administration and computer teachers.
T	The need to improve student ability to use computers by providing required support, sufficient computers → the output: students with high computer performance. (The need would be met by dividing the number of

	students by two, which would mean the computer lab would seat the right number of students and would enable teachers to assist and control, together with the help of the network service).
W	The belief that reducing student numbers and providing a network-based lab are good ways of improving students' fulfilment.
O	Schools administration.
E	Teacher schedule, students' timetable, budget, network specialist, facilities, and other physical support.

Maintenance of Lab Facilities System-3

This system was fully supported by the computer teachers as they were not trained to deal with all kinds of computer problems. Root Definition and a CATWOE model related to this system were presented in Table 13.

Table-13: System 3 Root Definition and CATWOE analysis.

Root Definition (System 3)	
A system owned and operated by girls' secondary schools to regularly repair and maintain *computer* equipment by signing a contract with one of the *computer technicians in order to provide students with maintained lab facilities and an appropriate number of working computer units.*	
C A T W O E	
Elements	**Description**
C	Students
A	Schools administration.
T	The need to have a maintained computer lab by regularly checking and fixing any broken facility → the out put: large number of working computers and maintained facilities. (The need met by a contract with a computer technician).
W	The belief that having a contract with computer technician experts is a good way of ensuring facilities maintenance.
O	Schools administration.
E	Budget placed by school, facilities, teachers and students.

In order to accomplish any proposed root definitions or any relevant systems, certain activities should take place in a certain way. These required activities can be depicted by drawing a conceptual model as described by Checkland and Poulter [12]. A conceptual model for the suggested root definitions is presented below.

Conceptual Model

According to Checkland and Poulter [12], it is important to describe the necessary activities for accurate performance of transformation without describing the activities of the outside world. In this stage, at least one of discussions with those involved in the situation is important to validate the conceptual models. Therefore the required activities to perform constructed root definitions 1 and 3 in this study were illustrated initially by the researcher's belief that might not give high-level activity descriptions or might not be completely valid. Conceptual models for systems 1, 2, and 3 were presented in Fig- 4 to 7.

Fig- 4: Initial Conceptual model derived from root definition 1

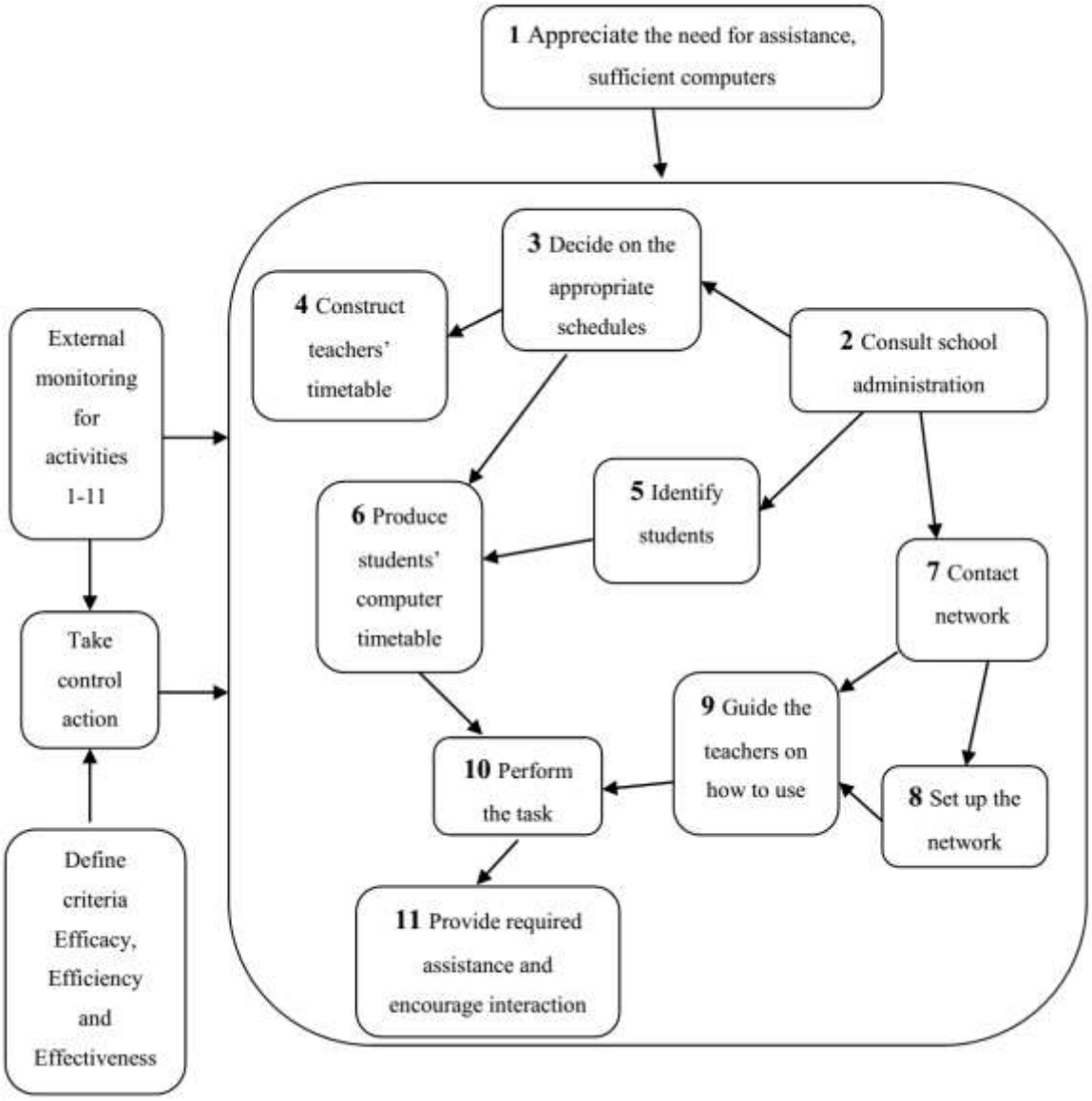

Fig-5: Conceptual model derived from root definition 2

This model is thought to be useful and valid especially the part regarding dividing students into groups and scheduling after discussion with the teachers and with some modifications. Consequently, the model would be more accurate if the later task was modeled separately. Fig-6 describes the initial sub- conceptual model with slight modifications.

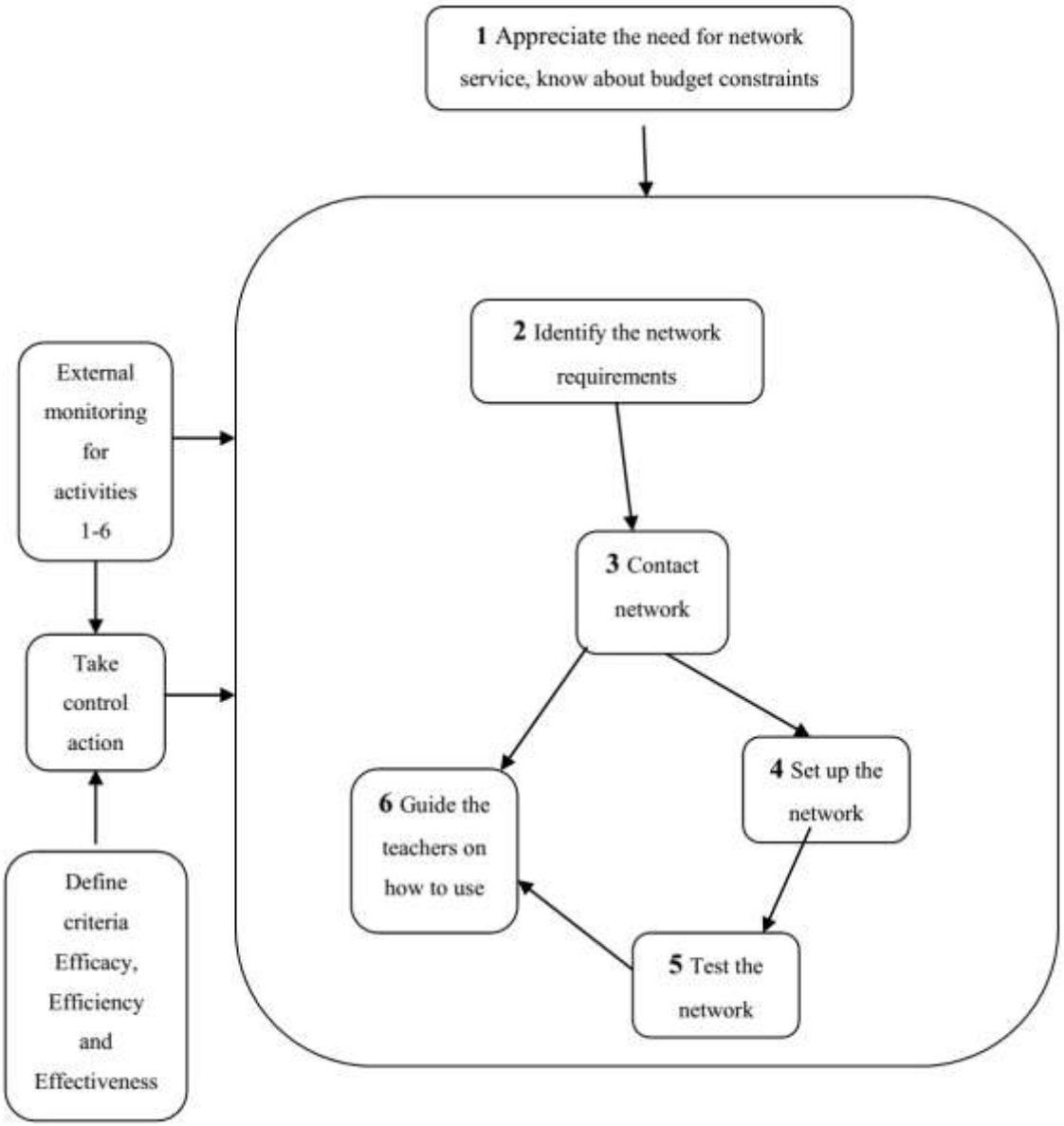

Fig-6: Initial sub-model derived from conceptual model 2

Figure -7 decribes the initial conceptual model derived from root definition-3.

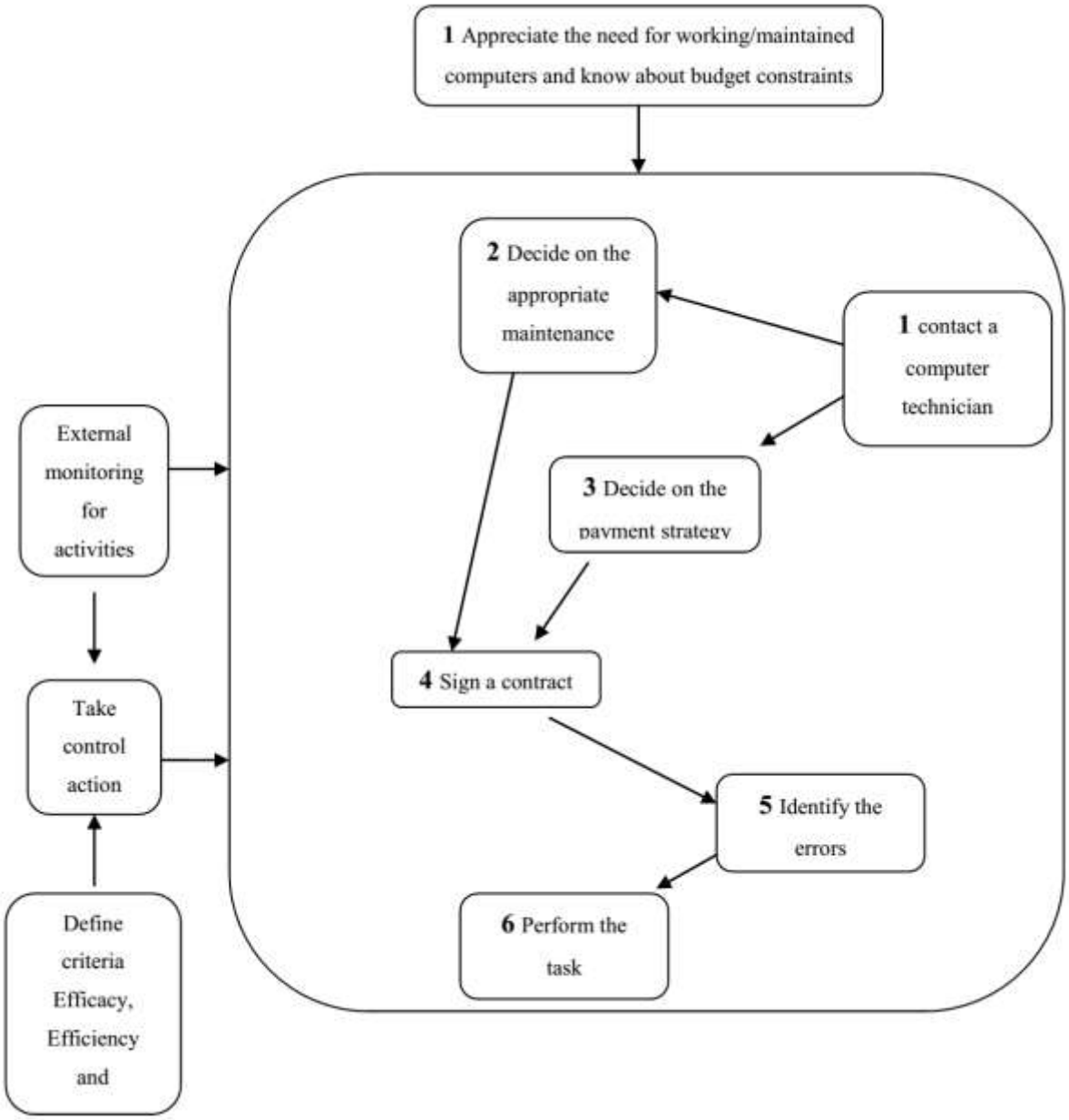

Fig-7: Initial Conceptual model derived from root definition 3

Stages five and six

Information needed after constructing each model was discussed using a matrix approach to avoid confusion [23]. Some of the activities needed for constructing the models are given in Tables 14 – 17.

Table-14: Matrix approach for activities 4, 5, and 10 from Conceptual model 4.2.

Activities / Input	4-Decide on appropriate updating strategy	5-Identify suitable method of delivering	10-Update when necessary.
	>collect/suggest different updating strategies. > understand the nature of updating strategy needed. >practise the strategy selected/discussed. >modify if required.	>collect/suggest different delivering strategies. > understand the nature of delivering strategy needed. >practise the strategy selected/discussed. >modify if required.	>review the material content regularly . > identify the subjects that need updating or replacement. > search the resources. >prepare the modification. >update.
Output	- fully constructed and effective updating strategy.	-useful delivering strategy.	-updated content.
Measures of Performance	------	------	-------

Table-15: Matrix approach for activities 5, 6, and 11 from Conceptual model 4.3.

Activities / Input	5-Identify students groups	6-Produce students' computer timetable	11-Provide required assistance and encourage interaction
	>Review student records. >Select appropriate way to divide students; for example, mix of high and low performance students. > divide students into groups. >give a name to each group. >inform students about their groups.	>Review class timetables. > Review identified groups' records. >construct each group's timetable. >Inform students about their new timetable.	>Help students during the work. > Ask if any help needed. > provide individual help. > encourage students to ask questions and answers. >encourage students to help each others.
Output	-good parlance groups.	-groups' timetables.	- interactive and assistant learning environment.
Measures of Performance	------	------	-------

Table-16: Matrix approach for activities 2, 5, and 6 from Conceptual model 4.3.1

Activities / Input	2 Identify network requirements	5 Test network	6 Guide teachers on how to use it
	>identify all current capabilities and equipment of the school lab. > confirm the condition. >confirm the services required. >recognise requirements for setting up the network software. >recognise Networking Engineering Requirements. >identify the cost.	>perform the established network. > conduct different procedures. >identify errors. >fix the errors.	>arrange the time. > present the network equipments, advantages, ..etc. > demonstrate the network. > explain and perform tasks. > ask for demonstration. >hand out network guide
Output	- clear perception about network needs.	-tested network.	-trained teachers.
Measures of Performance	------	------	-------

Table-17: Matrix approach for activities 2, 3, and 6 from Conceptual model 4.4

Activities / Input	2 Decide on appropriate maintenance strategy	3 Decide on payment strategy	4 Sign a contract
	>collect/suggest different maintenance strategies. > understanding the nature of maintenance strategy is needed. >identify its advantages and disadvantages. >modify if required.	>select the appropriate method of payment (salary, wages, piecework, etc). > identify the cost. >make agreements for both sides.	> sign a contract
Output	- identified maintenance method.	-recorded payment method.	-signed contact.
Measures of Performance	------	------	-------

A comparison was done between the structured models' activities and the real world activities to generate some possible changes for issues existed between the currently going on situation and the requirements to improve the situation. As a result, a partial comparison was constructed for the Conceptual model by the researcher being the only system for keeping contact with its stakeholders (teachers). Data in Table 18 described the comparison Matrix for providing assistance during the computer session (system2 - conceptual model 4.1).

Table-18: A partial comparison Matrix for activities 5, 6, and 11 from (system 2 Conceptual model 4.3).

Activities	**Is it wort**	How could be done?	Who could do it?	Where and When could it be done?	**Com ment s**
Identify students' groups	Yeas	-Meeting -Teachers and school administration responsibility	- Teachers Administration staff	- Once the agreement had obtained from school administration - Could be done for each semester - Can be done in meeting room	----
Produce students' computer timetable	Yeas	-Teachers and school administration responsibility -By reviewing students groups and teachers timetable	- Teachers Administration staff	- Once the group identified and teachers timetable constructed - Can be done in meeting room	----
Provide required assistance and encourage interaction	Yes	-Computer teachers responsibility -Can be done individually or for a group of students -Can be done using the network	-Teachers -Could be students	-Could be done in the lab or class. - Must be done when it is needed _ Could be done every time teacher explains something new. -Could be done when student failed to achieve task at hand.	**Recommended to provide students unlimited access to computer lab to be able to practice and have**

It was recommended that students should be provided unlimited access to computer lab for practice and subsequent access to outside class for adding activities in the model as a means of providing assistance outside the formal class. Figure 8 showed the Conceptual model after adding this activity.

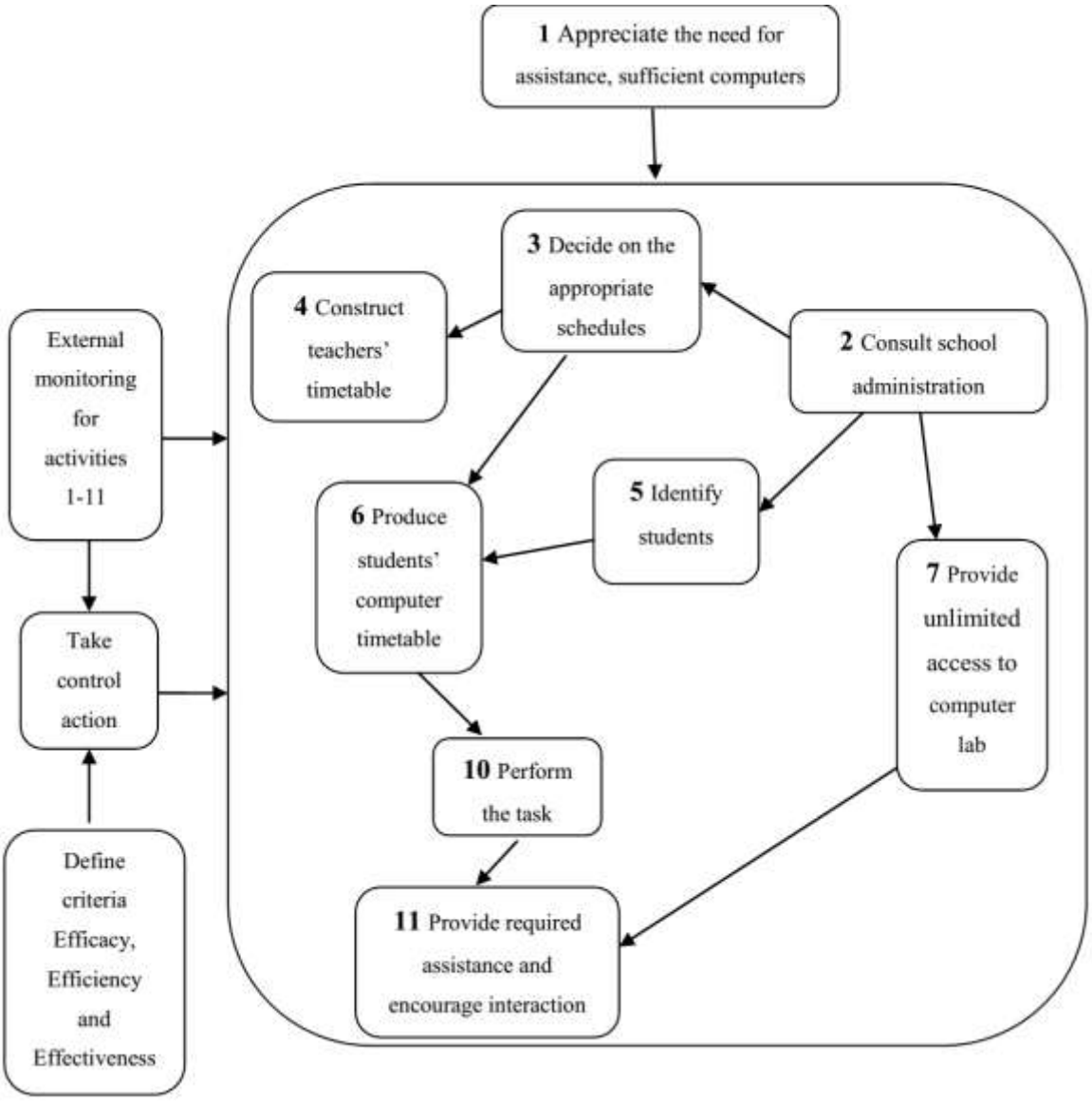

Fig-8: Conceptual model derived from comparison Matrix 4.8.

Stage seven

This stage covered the suggestions and improvement to the changesin previous stages that should be applied and requires the implementation of these modifications. Since the SSM was considered as a cycle of discussions, this means that for any single change that occurs, the whole problem situation should be re-examined [20]. However, in this study there was a slight change, considered as a valuable change, made to (Providing Assistance) the system, since this application was not implemented yet.

DISCUSSION

Achievement of the Questions

In addition to the use of SSM as a method to deal with computer teaching in secondary schools, a number of questions were needed to be investigated. These were 1): What did students see as the main deterrents to developing their academic achievement regarding computer technology? 2): What did teachers see as the main deterrents to teaching computer skills in girls' secondary schools? and3): What can be done to improve and tackle the obstacles to computer education?

In this study, questionnaires and discussion were used to gather sufficient information regarding the above questions considered to be an assistant tool for implementing the SSM at a later stage.

With respect to question one, it was found that a number of obstacles prevented the students from developing their computer academic achievements and skills at schools. For example, a large proportion of students revealed that the content of the module was ineffective and was further clarified in the answers to the first question which showed that 58% of the students believed that the theoretical part of the module is very intensive than required. On the other hand, 44% students stated that it reviews computer topics and

information systems that were old and from early stages. Also, a high percentage of students (67%) criticized the practical content of the module due to the older version of the software. In addition to the module content, the lack of assistance was one of the concerns, because 55% of students believed it as one of the main hurdles for achieving a good qualification. Moreover, 73% of the students were not satisfied about the session time and they believed this was one of the significant obstacles affecting their performance. Finally, the poor facilities of the computer lab were considered by 66% of the students for deterring them from practicing their skills.

With regard to the second question, a discussion with four teachers by E. Mail revealed the same obstacles as those faced by the students with regard to the session time, the module content, and lab facilities. Additionally, teachers showed that the lack of a network service was deterring them from providing the assistance required by the students.

Use of SSM Methodology for Computer Teaching

Regarding the development of rich picture for describing the current situation, in the computer teaching situation, the tool was fairly helpful especially in presenting the conflict between the students' and teachers' demands and the limitation of the program, and it helped in gaining better understanding and saving the time that would have been consumed in discussion with respondents. The most significant observations were presented by the rich picture that require much attention. These were:

- How could the module content be updated regularly on a *cost*-efficiency basis and with a shorter process time?
- How could support be offered to all the students within the time?
- How could the session time be extended within the restriction of the school time tables?
- How could the requirements of computer maintenance and adequate computer units be met in a situation like this?

All the above issues raised from the rich picture broadened the researcher's thinking and the participants (in this case, teachers). This proved the usability of rich picture in computer teaching and achieved a holistic view, especially with different parts associations.

This study further found that involving the participants even on a limited scale was valuable for finding solutions. In this study, the researcher found that the application of CATWOE was a practical means of ensuring that all important elements involved in the root definitions would be effective. In terms of forming the conceptual models for each root definition, this study found that forming a model can be very easy since the necessary activities must be at a minimum set of components without relating it to the real world. However, it was complicated in some situations due to inadequate experience of the researcher. In contrast, the situation of modelling (providing assistance and sufficient computers – model 4.3) was demonstrated to be valid since the participants helped with their experience of the activities that required being involved when dividing students into groups and teaching with a double amount of sessions.

A matrix was used to identify the information needs for each conceptual model (initial or final). In terms of comparing the models with the real world, potential changes can be made by addressing important questions (How could be done?) (Is it worth doing?), etc. A useful modification to the conceptual model was done by adding a new activity which was not in the real world and thought to be very helpful (provide unlimited access to the computer lab).

Finally, since the final stage of SSM involved carrying out the changes presented in the previous stage, it was not possible to discuss the impact of the changes which were identified to develop the situation as documented in this study with a timeframe.

CONCLUSION

This study made an effort to find out the current difficulties and obstacles facing the new teaching program of computer technology from both the teachers' and students' perspectives in Al Qassime city in Saudi Arabia using SSM as a computer teaching tool to facilitate the evaluation and improvement. The study presented and discussed the implementation of the SSM in the schools context within the taught computer module.

The application of the SSM in present situation partly achieved some of the study objectives due to many limitations. However, the achievement of this application was presented in the rich picture which was fairly helpful especially in presenting the conflict between the students' and the teachers' demands and, the limitation of the program and giving better understanding of the situation. In addition, the achievement of the other stages was presented in system-2 which about providing required assistance to the students during the work and was thought to be helpful procedure. However, since it is not yet adopted, it is impossible to present the evaluation of this system. The suggested system regarding new strategy for updating the content would be very helpful if it was adopted since it is comprehensive and would fully examine the application of SSM methodology. This study recommended the application of the SSM in schools context but within the context of individuals' conflict situation.

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