Empowering the Skill Development of ICT/Computer Science Undergraduates in Large Classrooms through an Empirical Pedagogical Model –In the Sri Lankan Context

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***Abstract*—**The main objectives of this paper are (i) identifying the quality status of Information and Communication Technology/ Computer Science (ICT/CS) education in Sri Lanka against the international standards (ii) specifying the gap if there is any, against the international standard, (ii) taking actions to minimize the quality gap and finally developed a prototype model utilizing existing human and physical resources to enhance the quality of ICT/CS Education through an empirical approach to achieve the global competency. This type of empirical exploration is timely applicable to achieve the global competency in ICT/CS education, since Sri Lanka is experiencing a rapid development in the Asian region. To achieve the objectives of this study, it was carried out in two phases. In order to identify whether there is a deficiency in the quality status of the ICT/CS education in the university system of Sri Lanka, international standards of the education are compared and the existing gap is driven using gap analysis in phase I. As the quality of the Teaching and Learning (TL) process which is one dimension of the quality education consists of different sub processes: curriculum design, pedagogical design, implementation quality, outcomes assessment and resource provision, quality pedagogical design is one of the most significant component of the quality education and it is chosen as a way to enhance the quality of ICT/CS in this study. In phase II the ultimate goal was achieved, which is to organize the best possible pedagogical techniques to formulate a model to empower the skill development of ICT/CS university students of the selected sample, in order to minimize the specified gap in the local context in a sustainable way. Though this study mainly targeted for developing the skills of students, knowledge and attitude development of students also were achieved, thereby this study involves knowledge, skills and attitude (KSA) development of ICT/CS students. To drive the model large group practical oriented classroom was chosen as the main target since most of the ICT/CS undergraduate courses are practical oriented and the degrees are conducted for large groups in Sri Lanka. Experimental approach was chosen as the approach to reach the target of the phase two. By applying different active learning techniques to individuals and incorporating the collaborative empirical approaches, this experiment steered a series of continuous practical based assignments other than the lectures which was conducted using some selected pedagogies within the limited time. Moreover the bloom's taxonomy is used to achieve the leaning outcomes which are not fully covered by the face-to-face lectures by incorporating the Blended learning techniques. Further, with valid testing, this study uses reflective practice theories, feedback of students and peer lecturers in a cyclic way to fine-tune the proposed model after the each experiment. Not only the quantitative but also the qualitative measures were taken in order to derive correct and accurate results from the evaluation. Ability to test students' own knowledge individually, improving the presentation skills, allowing them to learn their own are positive feedback received from the students and the peer lectures. At the end, when implementing the proposed model, following achievements were obtained: students percentage in the mark range 0- 19 was reduced from 3% to 0%, in 45-59 mark range student percentage was reduced from 39% to 14% and in 75-100 mark range student percentage was increased from 2% to 40%. Therefore this study revealed that the skill development of each individual can be improved through this pedagogical model which saturated with active learning techniques.

***Keywords*—** ICT/CS education, Pedagogical techniques, Practical oriented large classroom, Quality education

I. Introduction

At present, Information and Communication Technology (ICT) has been merged to almost all the activities in human's day-to-day life. Therefore ICT education has gained a significant amount of weight in the education process. When considering the education process higher education plays a major role in producing high quality and skillful professionals to the society. Therefore the quality of the higher education should be improved. Quality of the higher education depends on the dimensions such as quality learners, quality learning environments, quality content, quality processes, and quality outcomes [1]. The effectiveness of the Teaching and Learning (TL) process consists of five sub processes; curriculum design, pedagogical design, implementation quality, outcomes assessment and resource provision [2]. Among these sub processes, pedagogical design is an important component and it is an independent factor regardless of the standard design of the higher education where the pedagogical techniques are easily adoptable by the local universities. Contemporary definitions describe pedagogy as the art, profession or science of teaching [3]. According to [3] pedagogy can be defined as an effective way of describing the relationships between

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teaching, learning and assessment in classrooms. They believe to talk of pedagogy is to talk of the appropriate ways teachers interact with learners.

The current local TL process can be improved by thorough analysis of the quality gap of the pedagogical design in the TL process of Information and Communication Technology/ Computer Science (ICT/CS) education between the local and international university system. As a gap is specified between the applications of various pedagogical techniques in other countries and Sri Lanka, this research was carried out to improve the quality of the pedagogical design of the TL process by studying those application and building a pedagogical framework for ICT/CS education in the university system in order to ensure the sustainability of the ICT/CS higher education in Sri Lanka. Also as most of the universities of Sri Lanka as well as other countries consist of undergraduate degrees which are carried out for large groups and the researches which have been done in other countries have focused on classrooms which have small number of students, this research study is focused on large classrooms (groups which consist of large number of students). Among the practice oriented courses and theoretical based courses, practice oriented courses were selected for our research concern as the majority of the courses in ICT/CS are courses which are practice oriented. To build the pedagogical model for these large practical oriented classrooms, hypothetical model was designed and applied as a series of practical based assignments with the lectures which are rectified according to the active learning pedagogies. According to the feedback of students and peer lecturers and as an outcome of the reflective practice the model was revised. After some several revisions which are attained through this recurring process final model was derived. From the evaluation, it was revealed that the improvement of students' skills can be achieved successfully by using the formulated pedagogical model in large group practical oriented classroom.

II. Research Problem

At the current situation of Sri Lanka, minimal amount of evidence are found related to the quality status of the ICT/CS higher education in the university system and regarding to the curriculum design process, some Sri Lankan universities follow the Association for Computing Machinery (ACM) guidelines and internationally accepted guidelines, but there are no evidence about the pedagogical design guidelines usage. Therefore in the current situation there is a problem with identifying the actual gap between the local state of the pedagogical design and the international pedagogies under the TL process which was addressed in phase I.

III. Aim of the Research Study

The aim of the study is to identify whether there is a quality gap between the local and international pedagogies and if there is any gap, formulate a framework using the identified best pedagogical techniques under the TL process in order to enhance the current state of the pedagogical design. The framework is formulated with the aim of improving the pedagogical design of the large group practical oriented classroom as it was identified as the major audience of which the quality pedagogy is lacking in the university education in Sri Lanka. Final aim of the study is, enhancing the quality of ICT/CS education by improving the pedagogical design.

IV. Background Study

ICT and CS play a significant role in this new era of globalization surrounded by a high-tech global economy. In order to build up high quality Information Technology (IT) professionals for this new technological era, the ICT/CS higher education is the fundamental requirement. Prominent degrees that are offered under higher education in lots of countries are Computer Science, Information Systems, Software Engineering and, Computer Science etc. [4].

Since globalization increases the demand of qualified IT professionals, there is a significant demand for the professionals who are related to IT in Sri Lanka also. Because of that IT higher education has become an extremely important area in the tertiary education in Sri Lanka. Currently there are many ICT/CS degrees which can be obtained from government universities in Sri Lanka [5]. Many government and private universities are engaged with the blended learning among different learning concepts. Therefore blended learning process of these universities will be examined in this study. To benchmark the best practices with the local standards that are used by these universities, international standards on ICT/CS education will be useful. The international standards are a set of norms that individual degree-awarding bodies set and maintain for the award of their academic credit or qualifications [6] and the TL process is one of the important factors for which international standards affect [7]. Under the TL process, the application of pedagogical techniques is a norm which plays a wide role in the quality of the pedagogical design of the TL process.

Most of the ICT/CS undergraduate degrees in Sri Lanka as well as the other countries [8] are designed for large classrooms where the students are involved in the passive role of listening to the wisdom delivered by a lecturer at the front of a lecture room. Due to the large number of students in a classroom, the curriculum that needs to be covered within the limited time and evaluation issues, the skill development by using different pedagogies of students is unproductive. At the end of any degree course, students should have obtained the expected skill development according to the learning objectives specified in the course of the study. Because of the inability of applying the effective pedagogies, achieving the skill development has become a difficult task.

The majority of the courses in ICT/CS degrees are designed as practical oriented which leads to the skill development of undergraduates. Therefore active learning is essential to provide opportunities for students to meaningfully talk and listen, write, read, and reflect on the content, ideas, issues, and concerns of an academic subject, in order to achieve KSA development.

V. Theoretical Framework and Related Work

Pedagogy is often represented as the philosophy and instructional approaches associated with good teaching. Nevertheless it is seen as a vague concept while some educators use it as a synonym for teaching, but pedagogy means more than teaching [9]. The identified teaching learning concepts and pedagogical techniques throughout the literature are described in this section.

Student centred learning is one of the teaching learning techniques which gives the responsibility of the student learning to his own by replacing lectures with active learning, integrating self-paced learning programs, cooperative group situations, etc. Also it is vary from the traditional teacher centred learning in a way that, complimentary activities are provided, interactive in nature, enabling individuals to address their own learning interests etc. [10]. It is an approach where the learner choses what to study, how to study and why he is going to study it [11]. It is useful for the education process as it can change the face of the education into a lifelong learning process in which the student seeks solutions to problems without complete dependency upon an instructor [10].

"Problem Based Learning (PBL) [Boud and Feletti 1997; Dolmans et al. 2005] is an instructional approach that makes the student the focus of the learning process, seeking to empower them such that they take responsibility themselves for their own learning" [12]. According to [13], PBL should be used to teach students in computing courses. PBL lets student to critically think about a problem, solve the problem and gain the knowledge related to a specific area. According to [14], in PBL, problem is given to the student before instructor enters to the class to discuss in small groups to identify the problem and related things. During the independent study of the students, they will have to study deeply using web, libraries and other sources and finally share the things they have learnt [12]. Finally students present their solution to the problem and review what they have gained from going through the PBL process. In PBL the content replaces in to a problem, lecturer replaces into a coach and student replaces into a problem solver [14].

Implementation of PBL has shown a positive development in different subject areas such as medicine and also in computing courses [12]. According to [15], Hybrid PBL course is designed for the first year students of the CS in National University of Ireland (NUI), Maynooth. The steps which should be taken and resources which should be added to the learning environment are included in Hybrid model of PBL. The duration of the problem, PBL style lectures and the assessment methods are the newly added things to this Hybrid model. When implementing, training for staff was given to adjust to the role of coach. Also induction program was organized for the students [15]. Groups were consists with 5-7 with all the resources and PBL journal was provided for them. Three criteria into which problems fall were identified as extendible conceptual problems, non-extendible conceptual problems and programming problems [15]. The assessment method that was used for this approach is examination. In addition to that formative assessment and peer assessment was used to evaluate the students' performance. To assess this method questionnaires, interviews, student feedback were used and feedback was quite positive for the PBL process. Also the performance of the students has increased comparing to the results of the students of previous years [12].

Reflective learning is another identified teaching learning technique. Once John Dewey has stated, "We do not actually learn from experience as much as we learn from reflecting on experience." [16]. According to D. Kolb, learning is the process whereby knowledge is created through the transformation of experience [17]. Reflective learning has become increasingly important in higher education as it helps students to develop the new knowledge in their lifelong learning [18]. Kolb's reflective learning cycle comprises four different stages [17] while there are six stages in Gibb's model of reflection. Also both John's model of reflection and Atkins and Murphy's model of reflection consists of five stages [19].

There are benefits which are reported by students of CS higher education and the studies has accepted that reflection is a needful aspect for some courses in CS as critical thinking and analytical skills are needed for them [20]. Learning portfolio is a great way to motivate students to express their reflections and it has been widely known in academic fields. Writing the reflections in a portfolio accurately and in an organized manner with the support of a mentor will improve the learning of students [21]. The e-portfolio is a web based version of the learning portfolios which is widely used in universities. The e-portfolio can be considered as a teaching tool, a learning management tool and an alternative form of learning assessment [22]. To enhance the efficacy of the learning, e-portfolios can be used as an aid for reflective learning.

The term collaborative learning refers to an instruction method in which students at various performance levels work together in small groups toward a common goal. Many research studies suggest that collaborative learning is very effective in college level and the development and enhancement of critical-thinking skills through collaborative learning is one of the primary goals of technology education [23]. According to [24], the main three elements behind this concept can be interpreted as "two or more", "learn", "together". According to a study carried out by Richard m. Felder and Rebecca Brent [25], cooperative learning approach is one of the methods to improve the teaching quality. As advantages, cooperatively taught students tend to exhibit better grades on common tests, greater persistence through graduation, better analytical, creative, and critical thinking skills, etc. [25]. Contributing student approach and Ball Bearing method are some collaborative learning approaches. In contributing student approach [26] the learner is expected to adopt a set of new roles such as a co-creator of learning materials, a responsible selector from a variety of real-world resources, a person who extends the textbook and the work of others, etc. Ball Bearing method [27] also another pedagogical pattern which can be used to exchange the information and interpretations very effectively rather than doing the sequence of group presentations.

In a study carried out by Anuradha A. Gokhale [23], 48 students in an electronic course, who are enrolled at Western Illinois University, Macomb, Illinois were used to measure the effectiveness of collaborative learning. The study was consisted with two parts; lecture and worksheet and the sample was divided into two; traditional learning group and collaborative learning group [23]. For traditional learning the lecturers first explained the concept to the students then the students worked on the worksheet individually. After 30 minutes, the students were provided the answers, asked to compare their answers with those and a post test was given for them [23]. In the collaborative learning the first step was to clearly specify the academic task. After explaining the collaborative learning structure to the students an instruction sheet that pointed out the key elements of the collaborative process was distributed. They were instructed to listen carefully to comments of each member of the group and be willing to reconsider their own judgments and opinions. After that the group will arrive at a solution and the students were asked to compare their answers with real answers by giving the answers and a post test was given for them [23]. According to his opinion there are three ways of forming groups; self-selection, random selection and criterion- based selection and he used the self-selection method. It is argued that small groups help to ensure that all the people in the group are contributing to the work. So the author has selected small groups. Considering other factors students had provided the same environmental conditions to both, provided the activities in the same time and pre-tests and post-tests were used to minimize the effects of the prior knowledge about the subject. According to the findings of the study the author has been able to prove that collaborative learning is much more beneficial to improve the critical thinking skills of students [23].

John hammer [26] has applied the contributing student approach in two computing courses in 2005. Two groups were considered for the study. One group worked individually or in teams to prepare a learning resource on their topics and the other group worked in pairs to develop a case study and write a report and a poster highlighting the significant features of their case study. Several software systems were become the core components of the course such as "Aropa", Wiki – wiki. A main core principle of this approach is lectures becoming to class meetings. As this approach reduces the need for a traditional lecture, the time for the lecture was used to hold class meetings. In these meetings students discussed about the conflicting areas that they have found and the lecturer became the chair person and provide the necessary guidance. Improved communication, gaining ability to look in to a problem from different perspectives and enhancement of team work were some of identified advantages. Lack of fairness, more concerning with uploading lecture materials and neglected reading other posts were identified as issues. In this study the author provides a conclusion that this approach is effective at developing a range of desirable skills [26].

In activity based learning, teaching is carried out through activities that help students to participate both mentally and physically in the TL process and bring efficient learning experiences. The activities used for teaching process through this method can be categorized into three parts as exploratory, constructive and expressional [28]. According to [25], this approach can be used to improve the quality of teaching. According to McKeachie [25], after about ten minutes of the start of the lecture the attention of the student's beginning to draft starting from brief moments to longer intervals. So he concludes that small group exercises are a good method to keep the student's attention. Activity learning exercises address a variety of objectives [25]; recalling prior material and responding to questions, problem solving, providing analytical, critical, creative thinking skills etc. In a study carried out at North State University, a set of students in a chemical engineering course were taught using activity learning as the teaching technique in all class sessions by the same instructor for five semesters and the students completed their homework using cooperative learning approach. Also the academic and student performance were assessed each semester for both traditionally taught students and the selected group of students. The results showed that the students in the experimental group earned higher course grades than comparison group students in other courses also [25].

Construct instructional objective is another teaching method to improve the quality of teaching. Instructional objectives are statements of specific observable actions that students should be able to perform if they have mastered the content and skills the instructor has attempted to teach [25]. These can be grouped into six categories using the cognitive levels of Bloom's Taxonomy of Educational Objectives [29] according to the levels of thinking that the students should have. Well formulated instructional objectives can help instructors to prepare lecture and assignment schedules and facilitate construction of class activities also the students know what is expected of them; the more likely they will meet the expectations [25].

Assessment and evaluation of teaching quality also should be included in order to improve the quality of teaching [25]. Most institutions use only end of course student surveys to evaluate teaching quality but student opinions become important factor regarding the improvement of the quality of teaching. Meaningful evaluation of teaching must rely primarily on assessment of learning outcomes [25].

New approach was designed by Denise Tolhurst and Bob Baker [8], for first year undergraduate Information System course which is conducted for a large group through minimizing large formal lectures and encouraging both student independent learning and quality small group interactions. The course consisted with small regular workshop groups and weekly web-supported independent activities (WSIA) completed by students before attending class. The WSIA were intended to prepare students in the fundamentals of a topic of study that were to be later explored in either the workshops or lectures. Workshops were held in a room with flexible furniture, and the preparation of the seating and tables was varied from week to week depending on the activities to be undertaken on that week. The kinds of workshop activities

undertaken were aligned to a PBL approach. There were lectures with a focus of explaining the course structure and of introducing some preliminary content for the course, discussing the integration of the topics addressed in the course up to some point and overview content covered to that point, introducing some of the work that was to be address in the weeks ahead, course evaluations to be completed and a summary of the course content to be discussed and providing some information about the final examination. Student feedback questionnaires, weekly meetings of staff, observations and informal conversations with students were used as the course evaluation approaches and have achieved positive results for the approach [8].

VI. Methodology

This qualitative research consists of two main phases, which are equally weighted. In phase I the international standards and the quality factors of the TL process and the application of the pedagogical techniques in other countries was revealed. Then the current situation of the usage of pedagogical techniques in Sri Lanka was examined. Gap analysis was used to identify whether there was a gap between the International standards in TL process and the local standards in the TL process. Based on the gap derived by the gap analysis, the study was continued to improve our understanding on how to bridge the gap by enhancing the quality of pedagogical design in phase II. The suitable pedagogical techniques and other educational theories were identified through the gap analysis. Appropriate sample was selected in order to understand the curriculum and to design a framework using the identified pedagogical techniques to test in the practical scenario and measure the successfulness in the context of Sri Lanka. The detailed methodology will be explained in this chapter.

A. Phase I

Phase I was consists with four main steps as follows.

Step I: Identify the pedagogies that are applied in international level

This was one of the critical stages of this research as the whole study depended on identifying the pedagogies that are applied in the TL process of universities internationally. To identify the pedagogies, it was decided to gather the data through literature survey. Not only the real world application and experiment of different pedagogical techniques or TL techniques, but also different concepts which can be applied to build the pedagogical design were considered in the literature review. In order to assure the outcomes which are derived through the literature review about recognized pedagogical techniques an online questionnaire was made to provide for the international students who are following IT related degrees in well-known international universities which have gained higher ranks when consider the academic level and whose performance is competent in terms of teaching, research, knowledge transfer and international outlook. As this was used only to verify the existence of the techniques, questionnaire was distributed among few students who are following IT related degrees in universities in U.S.A. and U.K. Through the questionnaire, the existence of the identified pedagogical techniques were questioned and verified.

Step II: Define the target audience

The sample size of the research was decided as it is needed to gather data about the current situation of the pedagogical design in the TL process. After considering the facts 1st year undergraduates who are following the Bachelor of Information Systems (BIS) and Bachelor of Computer Science (BCS) degrees in University of Colombo School of Computing (UCSC) and in Bsc. (IT) Hons degree in University of Moratuwa (UOM) were chosen as the target audience to gather data.

Step III: Identify the current level of the pedagogical design of the university system in Sri Lanka

Set of questions were identified to find the answers from this stage and interviews were selected as the method to gather the data from lecturers while selecting questionnaire as the method to gather data from students to discover answers for the identified questions. In order to participate in the context and gather data from both parties, observations were selected. To identify whether the discovered international pedagogies using in the current TL process, pedagogical techniques were derived from the literature review and included the questions regarding those techniques. Other than that reasons for not adopting the pedagogies, methods used in current TL process were recognized as the questions to be asked. The interviewees of this research are lecturers who are doing lectures for the selected sample in UCSC and who have a good knowledge regarding pedagogical design. As the time requires for a MCQ based questionnaire is relatively very low it was used to collect accurate, relevant data from the students during the lecture period. Before giving the finalized questionnaire for the selected sample pilot test was carried out to refine the questions.

TABLE I
SELECTED SAMPLE FOR THE SURVEY

University	Degree	Number of students
UCSC	BCS	132
UCSC	BIS	32
UOM	Bsc. (IT) Hons degree	133

Research group was inserted as the members of the selected sample group and had been acted as students and listened to the lectures to understand the actual effective level of the lecture session and activity breaks, lecturer's presentation style, question and answer sessions, students' behaviour and teaching techniques were noticed through observations.

Step IV: Analysis of the collected data and Gap analysis

The collected data was severely analysed to understand the current state of the pedagogical design of the ICT/CS education in the university system of Sri Lanka. The data collected through the questionnaire which was given to the

students analysed using different tools and the data collected through observation and the interviewing the lecturers were analysed through group discussions by keeping the results of the literature review as the basis. Gap analysis was another important segment of the research study, because identifying the significant gap between the two portions, was required to carry this study further to minimize that identified gap. So after identifying the significant gap between the international level and the local level, the research was led to the phase II.

B. Phase II

Phase II was consists with four main steps as follows.

Step I: Design the initial model to enhance the TL process.

One of the most common feature in the various degree programmes in ICT/CS sector in the university system of Sri Lanka is having a large number of students in a class. So it was decided to design the framework for a class of large number of students. Also as ICT/CS degrees are very practical oriented, it was considered in designing the framework as well as selecting the audience. So as the first step an initial model for both lecture and practical classes was designed. Therefore the initial model consisted with two categories as lecture and the practicals.

Category I: Lecture

For each lecture, learning objectives are designed and course materials including the additional problem solving activities, supportive relevant web sites links, and education videos should be uploaded to the Learning Management System before the lecture session. At the face-to-face TL process, activities should be carried out with both individual level (including explanation, problem solving activities, comparisons, etc.) and group level. Under group level collaborative leaning activities such as complex problem solving activities, synthesis etc. should be included. All the activities should follow the reflective learning cycle.

Category II: Practical

The practical session should cover the concepts and applications of the lesson and should consist with both individual activities and collaborative learning activities. Both of these levels should include TL concepts such as students centred learning, problem based learning, Activity based learning etc. the whole practical session should assessed through written answers, QA session and Demonstrations. The practical session should follow the reflective learning cycle as well. Fig. 1 shows the cyclic process of practical sessions.

Step II: Select the suitable sample to carry out the phase II of the study.

After moving on to the phase II, the need of the selecting a suitable sample to carry out the phase II was raised as the target audience used in the data gathering phase was belonged to deferent degree programs as well as the large number of population was difficult to handle in the study. So after considering facts, 1st year undergraduates who are following the BCS degree in UCSC was selected as the suitable sample for the study and the "Data structures and algorithms - II" was selected as the appropriate subject to test the validity of the designed framework. So the curriculum of the identified subject was studied in order to take an understanding about the subject.

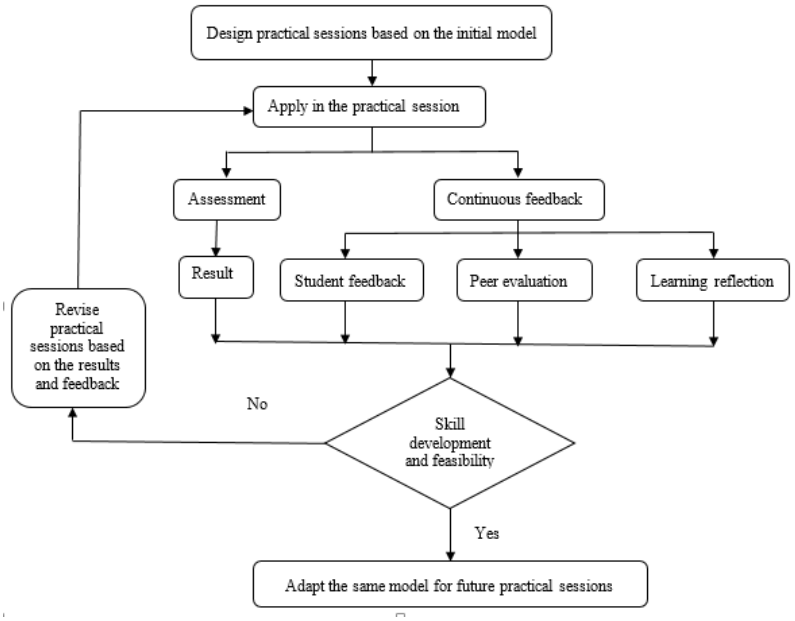


Fig. 1 cyclic process of practical sessions

Step III: Apply the initial framework in the real class room.

The initial model designed at the beginning of the phase II was applied in this step as three experiments.

Experiment I

For the lecture, learning objectives were designed and distributed specific to that lesson and course materials were uploaded to the LMS three days before the lecture session. At the face-to-face TL process, activities were performed satisfying the conditions of the model and followed the reflective learning cycle and reflected according to the results.

Experiment II

The practical session was carried out as a weekly basis assignment which had 40% contribution to the marking scheme of the subject. 148 students were participated to the relevant course and according to the resource capabilities those students were divided into three groups with approximately 50 students per session at the beginning of the semester. The time slot that was allocated to the each group was changed in every week in a cyclic way to keep the equality among the groups as the three practical sessions were held on three different time slots. For each group, 2 hours

were allocated for the practical session per week in addition to the lecture session. Three instructors and the lecturer participated to each practical session in order to carry out the evaluation. All the necessary resources such as computer, papers, etc. were provided to the students. And the guidelines for each practical session were uploaded to the LMS three days before the 1st practical session. The basic structure of the assignment consisted with three categories as individual level, sub group level and group level.

Individual level - this was the starting level of each assignment. As the name implies, all the students participated to this level individually. A question paper which was designed according to the relevant lecture session was distributed and the 25 minutes were allocated for the pre individual level. The question paper followed the blooms taxonomy and in order to improve the collaborative learning, students were provided additional 2 marks per each question of the pre individual level paper if all the students of the group answered correctly for the same question. It was published clearly in the guidelines of the practical session. 15% marks of each assignment were allocated for this individual level.

Sub group level - after finishing the pre individual level students formed into two sub groups within their groups according to the seating order and a question paper was provided to answer as a sub group. This paper required both written answers and demonstrations of answers. In order to improve the active learning, students were given activities within the paper. Further, the following techniques were incorporated in this group level: Collaborative learning, Peer Led Team Learning, Problem-based Learning, Team-based Learning Peer Instruction, Small Group Learning, Project-based Learning and Research oriented activities and also it followed the blooms taxonomy. 20 minutes was allocated for each group to discuss and share knowledge and 10 minutes were allocated to provide the answers which included physical activities, executable programs and its valid outcomes and a QA session. Also in the sub group level each student was evaluated individually within the group by the instructor. 40% marks of each assignment were allocated for this sub group level.

Group level - after finishing the sub group level students formed into their groups and a question paper was provided to answer as a group. This paper required both written answers and demonstrations of answers. In here also students were given activities within the paper in order to improve the active learning. Further, the same techniques which were used in the sub group level were incorporated in this group level as well. 20 minutes was allocated for each group to discuss and share knowledge and 10 minutes were allocated to provide the answers which included presentations, physical activities, executable programs and its valid outcomes and finally a QA session. Also in the group level each student was evaluated individually within the group by the instructor. 40% marks of each assignment were allocated for this group level.

In order to follow the reflective learning practice students were provided a link in the LMS to provide their learning reflection including student's contribution, learning outcomes from the assignment, thoughts and insights about the learning experience. Students had to provide their learning reflection before the expiry of 48 hours after completion of the assignment. 5% marks of each assignment were allocated for this learning reflection. Also verbal feedback from randomly selected students and instructors were obtained. Then the lecturer reflected accordingly and the reflection was implemented in the next series of assignments. This type of series of a practical oriented assignment was implemented throughout experiment II.

Experiment III

As same as the experiment II, the practical session was carried out as a weekly basis assignment which had 40% contribution to the marking scheme of the subject. 148 students were participated and they belonged to the same groups as in the experiment II. Practical was carried out in two different time slots, and due to that the time slot that was allocated to the each group was changed in every week in a cyclic way to keep the equality among the groups. For each group, 3 hours were allocated for the practical session per week in addition to the lecture session. Three instructors and the lecturer participated to each practical session in order to carry out the evaluation. All the necessary resources such as computer, papers etc. were provided to the students. And the guidelines for each practical session were uploaded to the LMS three days before the 1st practical session. The basic structure of the assignment was different from the experiment II and it consisted with three categories as pre individual level, group level and post individual level.

Pre individual level – as same as the experiment II, this was the starting level of each assignment and all the students participated to this level individually. A question paper which was designed according to the relevant lecture session was distributed and the 30 minutes were allocated for the pre individual level. The question paper followed the blooms taxonomy and in order to improve the collaborative learning. Students were provided additional 2 marks per each question of the pre individual level paper if all the students of the group answered correctly for the same question. It was published clearly in the guidelines of the practical. 15% marks of each assignment were allocated for this pre individual level.

Group level – after finishing the pre individual level students formed into their groups and a question paper was provided to answer as a group. This paper required both written answers and demonstrations of answers. In order to improve the active learning students were given activities within the paper. Further, the same techniques used in experiment II were incorporated in this group level: Collaborative learning, Peer Led Team Learning, Problem-based Learning, Team-based Learning Peer Instruction, Small Group Learning, Project-based Learning and Research oriented activities and also it followed the blooms taxonomy. 45 minutes was allocated for each group to discuss and share knowledge and 15 minutes were allocated to provide the answers which included presentations, physical activities, executable programs and its valid outcomes and finally a QA session. Also in the group level all the students were evaluated as a group by the instructor. So the final mark of the group depended on each member of the group. By that it was expected the students to share their knowledge among the group well. It was published clearly in the guidelines of the

practical. 40% marks of each assignment were allocated for this group level.

Post individual level – in order to measure the individual skill development of the students, this level was designed and after all the students finished their practical sessions, as it name implies an individual test was provided for all the students at the same time. As all the students were having practical 3 hours per week, the last hour from this time allocation was used for this test. This test was designed for 30 minutes and followed the blooms taxonomy throughout the paper. Before participating to the post individual test students were informed to share their knowledge in every possible way (discussions in canteen, common rooms, library, etc.) through the guidelines. 40% marks of each assignment were allocated for this post individual level. High weightage was given to this individual test than the other individual test as it measures the individual skill improvement and as the students have a separate time to ready for it.

As same as the experiment II, students were provided a link in the LMS to provide their learning reflection including student's contribution, learning outcomes from the assignment, thoughts and insights about the learning experience in order to follow the reflective learning cycle. Students had to provide their learning reflection before the expiry of 48 hours after completion of the post individual level assignment. 5% marks of each assignment were allocated for this learning reflection. Also verbal feedback from randomly selected students and instructors were obtained. Then the lecturer reflected accordingly and the reflection was implemented in the next series of assignments. This type of series of a practical oriented assignment was implemented throughout the experiment III.

Step IV: Evaluate the successfulness of the designed framework.

In order to evaluate the successfulness of the designed framework mainly 4 methods were used.

Pre-test and post-tests – at the beginning of the semester students were provided a 30 minutes question paper which covered the concepts of the subject. And all the marks gained through practical based assignments were taken into account when measuring the improvements of the students throughout the time period.

Peer evaluation - the productivity of the model in lecturer perspective was measured with the help of randomly selected instructors through verbal feedback.

Students continuous feedback – during the practical sessions, verbal feedback of randomly selected students were taken in order to follow the reflective learning cycle as well as for the evaluation.

Observation – research members participated to each lecture and practical sessions and observed the students behaviour, enthusiasm to learn etc. It was used to confirm the results gained through above three methods.

VII. Results and Outcomes

This section separately includes the results gained from the two phases mentioned in the methodology.

A. Results related to the Phase I

Throughout the phase I, different learning concepts were identified through the literature review such as Student centred learning, Problem based learning, Reflective learning, Collaborative learning and Activity based learning. In addition to these concepts there are pedagogies and practices that cannot be specifically categorized into these categories. Most of the international students who replied for the questionnaire have given positive answers for the existence of the pedagogies. So it can be concluded that the identified pedagogies are using in international universities and this set of pedagogies can be used to benchmark the TL process of ICT/CS education of universities in Sri Lanka against the internationally recognized pedagogies for university education.

75% of students of the local sample who responded for the questionnaire have stated that they are experiencing Blended learning in the university which is a positive outcome for our research as we are targeting the blended learning. The findings revealed that 84% of students are attending lectures regularly and thereby most of the students have the knowledge and experience regarding the lectures to express their thoughts about the pedagogical design.

TABLE II
SUMMARY OF THE ANALYSIS RESULTS

	% of vote
No activity breaks during the lecture	68%
Get activity breaks per 1 hour	49%
Get activity breaks for every 10-15 minutes	6%
Lecturers ask questions from the whole class	73%
Lecturers ask questions from group of students	9%
Don't consider the current level of knowledge of the students before lecturers start to teach	80%
Don't get continuous feedback from students about their teaching style/techniques	80%
Passive learning exists in the current process	68%
5 members are chosen for a group	49%
3-4 members are chosen for a group	15%
Identified active learning methods for students learning are helpful	84%
Students are able to understand the subject fully when activities are used	65%

According to the results it reveals that students are not getting any activity breaks during the lecture which is helpful to keep the attention of the students for the lecture and which helps to do the lecture interactively and even if some people get it, it is not efficient as the activity breaks should be given per every 10-15 minutes with efficient activities from which students can learn interactively. Also it shows that the method of asking questions is not efficient. Moreover, a lot of them experiences passive learning which is not positive for the pedagogical design. Number of students in a group work is a negative fact for the pedagogical techniques according to the results (see table II). The usage of the identified pedagogical techniques in the current TL process was analysed and activities (techniques) are categorized in to the relevant learning concept.

Figure 2 shows a one graph which is derived through the analysis. It reveals that that some of the techniques which are relevant to PBL are used for the current process, but some are

in the negative side of the responses. But to come to a conclusion about the usage, results from the interviews and observations were taken.

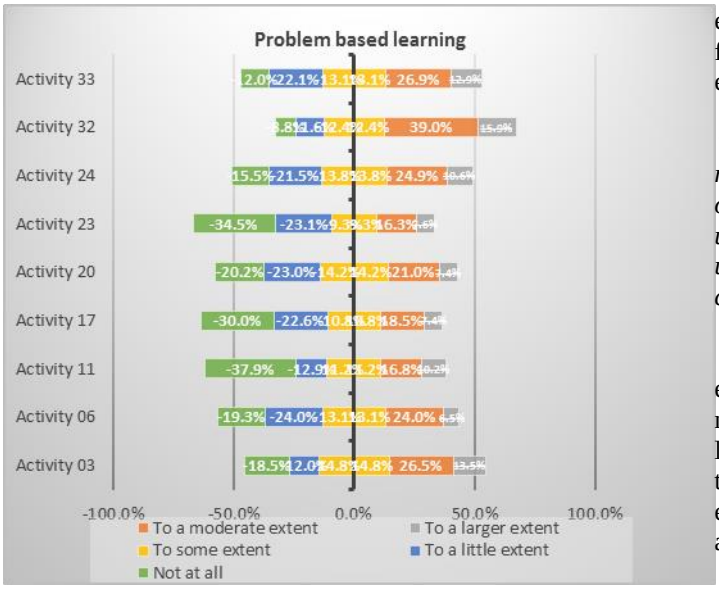


Fig. 2 Usage of Problem based learning

Qualitative analysis of the lecturer interview results reveals that most of the lecturers were using the face to face learning type widely and some lecturers used e-learning method with the help of the university undergraduate virtual learning environment. Most of the lecturers are providing the passive learning environment in the class room. They stated time, resources, the class size and the insufficient student dedication to the class room learning as the major constraints for not providing the active learning environment. But one of the lecturers who is using the activity based learning in her class rooms stated that the activity based learning can be successfully adapt to the current education environment. The analysis of the observation shows that the level of attention of the students is depend on the lecturing style, where more interactive sessions make the students actively participate the lecture session and the passive learning style make the students' participation to a lower level. Additionally the learning environment also impact negatively on the level of active participation of the students.

Using a gap analysis matrix a gap was identified between the international pedagogies and current pedagogies According to the outcomes of the gap analysis, it was proved that the following are wanting in the Sri Lankan ICT/CS undergraduate education in large class rooms. Active learning environment, Activity based learning, usage of pedagogical techniques and reflective practicing. Therefore this study continues to build a pedagogical model to minimize this identified gap.

B. Results related to the Phase II

In this section the results gained from all three experiments mentioned in the methodology is explained by evaluating the each experiment for its validity.

Results of Experiment I

According to the Experiment I lecture session was conducted in a different way with newly identified TL techniques from the phase I results. The outcome of experiment I was measured through student feedback, lecturer feedback and peer evaluation. Some feedback regarding to the experiment I has been shared below.

"First of all appreciate the effort and thumbs Up for the new method of learning. It facilitates the various ways of understanding. Given links are very useful for a better understanding. New method of teaching is far more understandable comparing with the old one, but at this phase can we complete the Syllabus on time?"

There were no quantitative measures taken in this experiment and it ends with the following problems: Planned notes were unable to cover in the given duration due to the large number of students in the selected sample and the techniques applied consumed a lot of time. Therefore this experiment proved that the applicability of large number of additional TL techniques in a large class room is low.

Results of Experiment II

Due to the failure of the experiment I, Experiment II was taken place. There the main focus was to introduce those pedagogical techniques in the practical class room. The outcome of the Experiment II is discussed below.

TABLE III
MARKS VARIATION IN THE EXPERIMENT II

Marks Range	Pre test	A1 Ind. Level	A1 Final Level	A2 Ind. Level	A2 Final Level
0 - 19	6	21	0	0	0
20 - 44	31	42	0	3	6
45 - 59	36	28	3	17	5
60 - 74	26	21	44	43	1
75 - 100	14	1	68	50	103

Table III shows the results of the students in the pre-test, assignment 1 and assignment 2. Here pre-test taken place without the application of new techniques to the current TL process. Assignment 1 and assignment 2 were carried out with collaborative learning and activity based learning as a practical oriented session. According to table III, in the assignment 1 number of students in the mark range 0- 19 was reduced from 21, 20-44 mark range reduced from 42, 45-59 mark range students were reduced from 25, 60-74 mark range students increased from 23 and 75-100 mark range students were increased from 67. Also in the assignment 2, there were no students in the mark range 0- 19 in both levels, 20-44 mark range increased by 3, 45-59 mark range students were reduced from 12, 60-74 mark range students reduced by 41 and 75-100 mark range students were increased from 53.

Fig. 3 and 4 clearly explains the skill development of students in the assignment 1 and 2 respectively. Also Fig. 5 below clearly explains the skill development of the students throughout the assignments due to the use of new pedagogical

model where the marks of the students increase throughout the three assignments. Therefore it is concluded that the use of the model in a large practical oriented classroom is successful.

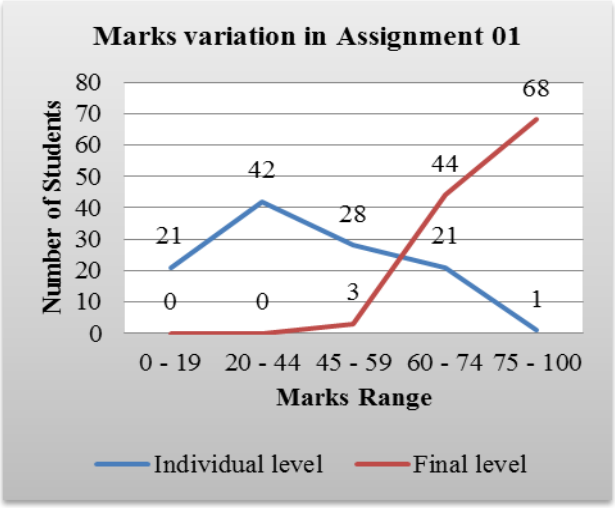


Fig. 3 Marks variation in assignment 01

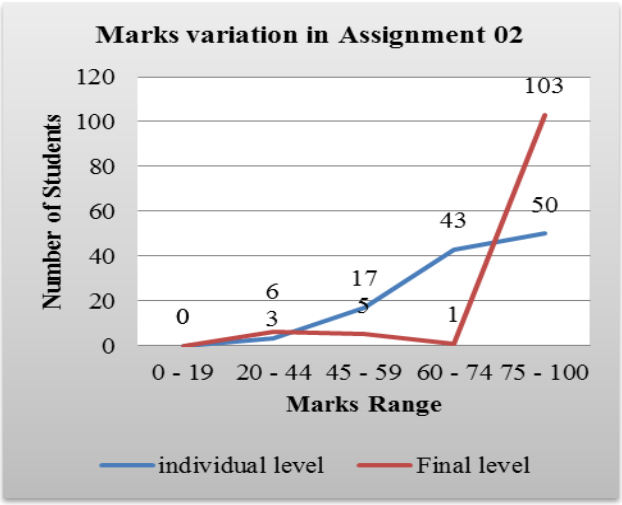


Fig. 4 Marks variation in assignment 02

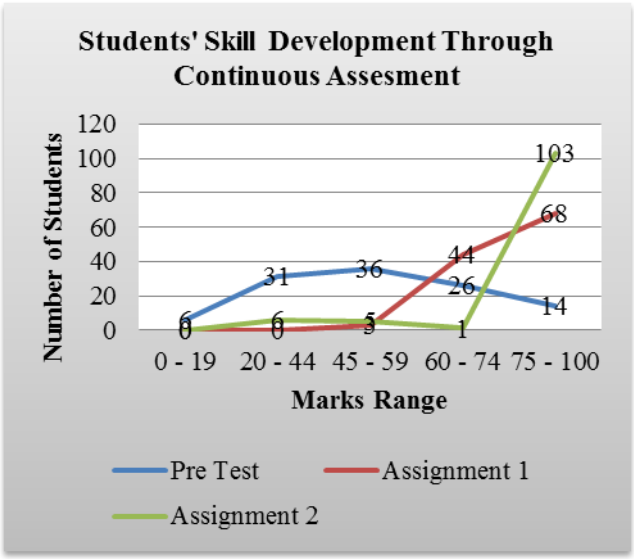


Fig. 5 Marks variation of the three assignments

The verbal feedbacks regarding to the assignment 1 and 2 from some students are discussed below.

"The assignment had three parts. So through the individual session i got to answer the questions individually and test my knowledge. Through the sub group session we were able to discuss the problems that each person had during the individual session and find better solutions for the answers. In the group session I basically got to improve my presentation skills. This whole session was about learning on your own. It was a good experience. We get to learn more about the subject matter when we are learning on our own rather than just listening to the lecture and studying for assignments. Since we are working in groups we get to improve your knowledge and learn from others as well. But since this is a very new approach for us we need more time to get used to something like this."

"I was able to improve and enhance my presenting skills as well as presentation preparation methods too. I personally believe this "OWN LEARNING TECHNIQUE" is a good method to improve our knowledge and understanding in subject matter. It is very interesting and enthusiastic method that stimulates ourselves to go and search information from books, internet, journals, pdf documents and other relevant sources. We also get to know about the new advance technology, creative and feasible ways of doing things. I also believe that we ourselves can discover and attempt new innovative ideas and concepts with no fear of criticism. Thus room for creativity and introduction of new learning techniques are stimulated in ourselves through "OWN LEARNING TECHNIQUE".

"This kind of learning experience is good and useful to improve our knowledge. But we have to use an extra effort to get ready for these assignments as they are in every week. So it gives us more stress to our minds. It's better if we can get these assignments three weeks by three weeks."

Through these qualitative measures it has been proven that the model enhances the knowledge of the students by collaborative learning and other TL techniques, but there is a time problem to be solved out to reduce the stress level of the students. Also the exact individual skill development has not been measured since the assessments are based on the group performance after the knowledge sharing session. Because of that reason experiment II was modified to the experiment III.

Results of Experiment III

Experiment III has been carried out to overcome the limitations in the Experiment II regarding to the stress level of the students and the high need of measuring the individual skill development. Experiment III included 3 assignments. In this way the students get enough time to collaboratively learn the relevant lessons effectively. Here the improvement in their individual performance is measured by comparing their Pre-Individual Test and the Post-Individual Test. By that way a quantitative measure can be obtained for each student's skill development. Also the qualitative data was gathered using students' feedback, peer evaluations and lecturer feedback.

TABLE IV
MARKS VARIATION IN THE EXPERIMENT III

Marks Range	A3 Pre Ind. Level (%)	A3 Post Ind. Level (%)	A4 Pre Ind. Level (%)	A4 Post Ind. Level (%)	A5 Pre Ind. Level (%)	A5 Pre Ind. Level (%)
0 - 19	3	0	2	0	3	0
20 - 44	31	12	24	7	27	14
45 - 59	29	19	32	19	39	14
60 - 74	21	31	25	32	29	32
75 - 100	16	38	17	42	2	40

Table IV explains the results variation of three assignments in the pre and post individual levels. In the assignment 3 students percentage in the mark range 0- 19 was reduced from 3, 20-44 mark range reduced from 19, 45-59 mark range student percentage was reduced from 10, 60-74 mark range student percentage increased from 10 and 75-100 mark range student percentage was increased from 22. In the assignment 4 students percentage in the mark range 0- 19 was reduced from 2, 20-44 mark range reduced from 17, 45-59 mark range student percentage was reduced from 13, 60-74 mark range student percentage increased from 7 and 75-100 mark range student percentage was increased from 25. Also in the assignment 5 students percentage in the mark range 0- 19 was reduced from 3, 20-44 mark range reduced from 13, 45-59 mark range student percentage was reduced from 25, 60-74 mark range student percentage increased from 3 and 75-100 mark range student percentage was increased from 38.

Fig. 6, 7 and 8 clearly explains the skill development of students in the assignment 3, 4 and 5 respectively. Also Fig. 9 below clearly explains the skill development of the students throughout the assignments due to the use of new pedagogical model where the marks of the students increase throughout the 3 assignments. Therefore it is concluded that the use of the model in a large practical oriented classroom is successful.

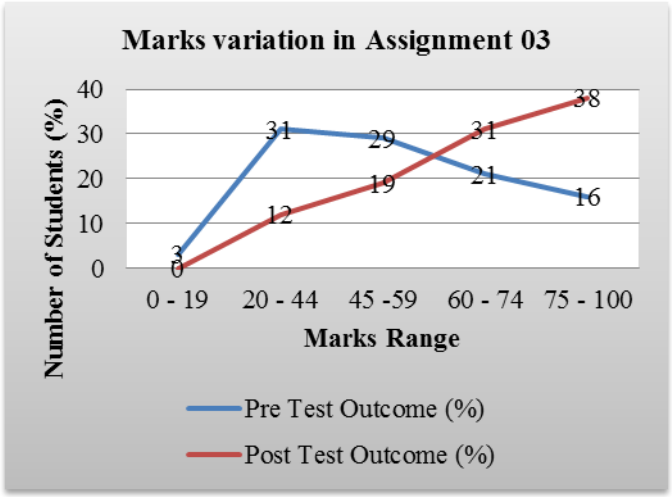


Fig. 6: Marks variation in assignment 03

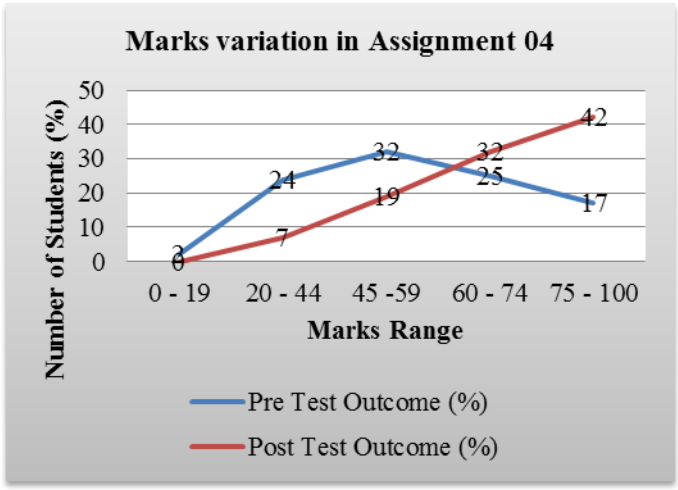


Fig. 7 Marks variation in assignment 04

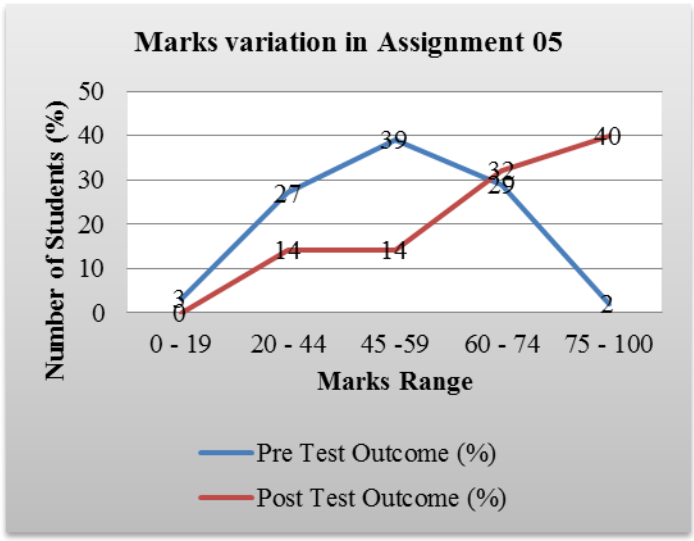


Fig. 8 Marks variation in assignment 05

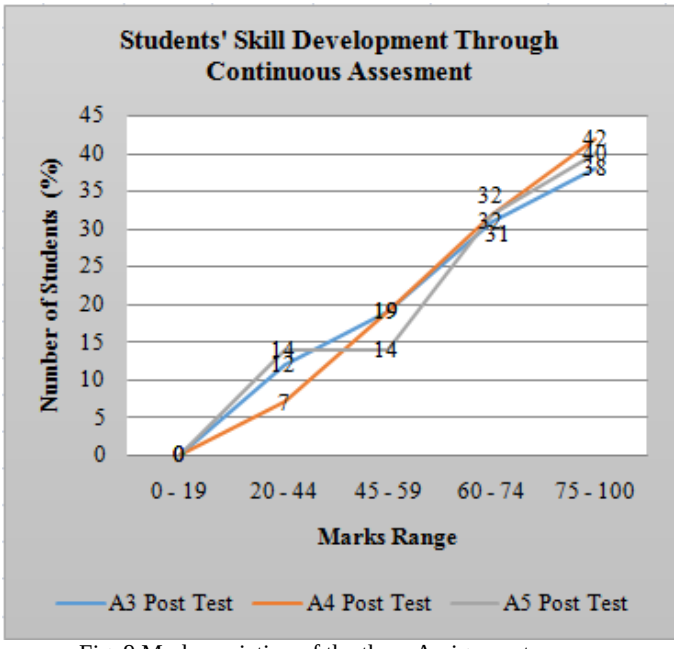


Fig. 9 Marks variation of the three Assignments

Qualitative analysis of the experiment III which was gained through the feedback from the students, lecturer and peer evaluators also shows that this model is successful in a large practical oriented classroom. Some of the feedbacks regarding to the experiment III has been given below.

"Since the group got to interact together and to react to a real question scenario prior to the post individual assignment, I believe that all the members in the group were able to learn something off each other and do better in their individual level assignment. I believe that this type of assignment is far more time saving and effective than creating PowerPoint presentations or physically showing how an algorithm works."

"In this method, we learn this subject hardly and it is useful to face the final examination with enough confidence."

Further, students' motivations and skilled development process will be shown by the followings Fig. 10-13



Fig. 10 Students are shown performing their individual part of the practical oriented assignment in the proposed model.



Fig. 11 Students are seen performing group activities of the proposed model



Fig. 12 Students are seen performing group activities and their presentation of the proposed model



Fig. 13 Students are seen delivering their feedback and their reflection before of the lecturer in the proposed model

VIII. Discussion

In the Sri Lankan context it is very clear, that the usage of active learning in large class rooms of ICT/CS and similar disciplines is minimal. Most of the class rooms have adopted the traditional passive learning environment due to various reasons such as lack of resource, insufficient time to complete the syllabus, resistance to change etc. Because of this reason Cooperative Learning, Problem-based Learning, pedagogical techniques usage, Peer Led Team Learning, Team-based Learning, Research oriented learning in the early ages of the ICT, CS and other discipline courses in Sri Lanka are lacking, although such techniques are greatly helpful for the skill development of the undergraduates. As a solution for this deficiency the proposed model is used to check the effectiveness in improving the skill development of the ICT//CS and other discipline undergraduates in the expected manner as the skill development is very essential. Applying a large number of additional TL techniques in the lecture session of a large class room is not effective due to insufficient time to achieve the expected learning outcomes. But considering the practical sessions this active learning can be applied very effectively. Collaborative learning and peer discussions during the practical sessions help the undergraduates to achieve skill development. Also learning objectives can be easily achieved by aligning them with stages of the Bloom's taxonomy, when setting and implementing their practical assignments. So as a whole, the proposed activity based model for the practical sessions will help to enhance the skill development of the undergraduates while applying a limited number of activities during the lecture sessions.

IX. Conclusion

This research study is focused on examining the quality status of the ICT/CS education in the university system of Sri Lanka by providing fascinating insights on the state of the pedagogical design in the TL process. By comparing the international pedagogical design with the local state of pedagogical design using the gap analysis processes, it has been proved that there is a gap in the pedagogical design in the local universities under the TL process compared to the international standard in this domain. In order to minimize the identified gap, large group practical oriented classroom which is a major audience in university system of Sri Lanka was

chosen and the pedagogical model was developed to achieve the skill development. As applying the pedagogies for a large classroom is ineffectual, the model was developed and rectified according to the feedback of students and peer lecturers and based on the reflections. The study showed a positive effect on improvement of KSA. Thus, it can be said that this pedagogical model is an effective framework for the pedagogical design of the large group practical oriented classrooms. This study can be extended to find a suitable pedagogical model for the large group theoretical oriented classrooms in ICT/CS university education.

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