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Experiences and Challenges of Teaching Science at Junior Secondary Level

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Abstract: Transformation of a conventional society into a conceptualized innovative scientific society is a herculean task. Educating science needs the confrontation of misconceptions and formation of correct concepts. Educational reforms in Sri Lanka were introduced with the intention of transforming the nation towards a scientific society. Even after four decades of such reforms, the national level G.C.E. (O/L) science achievement is not that satisfactory and still remains at 62%. Therefore, the scope of this study was to investigate the historical basis of science education in schools, pros and cons of present educational reforms and the challenges faced in achieving the national educational goals. To achieve above objectives, the study was conducted in two phases; critical review of literature on education reforms and a questionnaire survey on factors affecting the teaching-learning process using a sample of 126 science teachers in the Kandy District. Data were collected on qualifications, training, teaching methods, teaching aids and student achievements at the G.C.E. (O/L) examination. According to the findings, 'integrated science' had been introduced in 1972 for the first time at the junior secondary level to facilitate day to day life of people. Two minor revisions were followed; in 1985, 'introductory science' was introduced to year 5 and in 1998, 'science' was changed to 'environmental science' for grade six. The present reform; student centered, activity based 5E learning cycle was introduced in 2006. Although it is too early to conclude its performance, the teacher survey revealed that this particular method is not yet properly implemented by them due to various reasons. Majority of teachers still use other teaching methods and therefore some schools perform 100% while the others stay at 4.5% (mean = 41.1%). Although, the teacher qualifications and their training are at a satisfactory level, equity of resources, use of proper teaching methods and change of students' attitudes are still found to be challenging factors to reach the national educational goals.

Keywords: 5E learning cycle, Curriculum reforms, Integrated science, Physics concepts.

I. Introduction

Scientific knowledge and use of the scientific method are considered as the key factors of transforming a traditional society into an innovative scientific society. For providing a proper science education, teachers should practice especial teaching techniques and involve in confrontation of misconceptions and formation of correct concepts [3]. Science subject is full of concrete and abstract concepts [5] and correct concept attainment leads to science subject achievement. Sri Lankan education took the leadership in transforming the nation towards a scientific society through educational reforms during the last four decades. The integrated science was introduced to Sri Lanka in 1972 for the junior secondary level students with the motto of 'providing 'scientific knowledge for all' to empower the future generations to face day today life challenges [9]. After two minor revisions, a major revision was done in 2006 with the intention of changing the teaching learning method from traditional teacher centered method to student centered method, 5E learning cycle [12]. This method was first introduced and successfully tested

for teaching Biology in the United States of America during 1980s [2] derived primarily from a social theory developed by Lev Vygotsky during 1896-1934. Science teachers have been trained to change their role from the transmission to transformer or facilitator. The success of the constructivist teaching depends on multi factors such as teacher's performance, available facilities for conducting activities, access to information for exploration etc. Under this the teaching learning process, the student's role was expected to change into activity oriented and competency based learning style.

Even after four decades of such reforms, the national level G.C.E. (O/L) science achievement is not that satisfactory and still remains at 62%. Therefore, the scope of this study was to investigate the historical basis of reforms in science education at the junior secondary level in government schools, pros and cons of present educational reform and the challenges faced in achieving the national educational goals from the teachers' perspective. Since the inception, no one has studied the practicability of the 5E method at the school level and the views of teachers regarding the 5E method and its influence on student achievement from their perspective.

II. Research Design And Methods

The research was conducted in two phases; a critical review of literature on curriculum reforms on science education for the junior secondary level of the government schools of Sri Lanka. The objective was to investigate the history of science education of the country and evolution of the present science teaching-learning method. Further, the main changes and strategies introduced under the 5E method were investigated comprehensively to assess whether the intended objectives of the reform have being achieved from the teacher's perspectives. For this purpose, publications of the ministry of education on education reforms and UNESCO reports were used as the sources of information.

The second phase was consisted of a questionnaire survey for the teachers to access the degree of implementation of the 5E learning cycle method practically at the school level and challenges that the teachers face in achieving the expected education goals. In addition, data were collected on teacher qualifications, professional developments and student achievements at the G.C.E. (O/L) examination to investigate whether there was any correlation between teacher qualifications and students' achievement. However, in this context, the investigation was limited only to teacher's perspectives, and students' perspectives were investigated well in a separate research.

The questionnaire survey was conducted in the Kandy district by posting a pretested questionnaire to 346 randomly selected science teachers in each school representing all the schools in the district, which was a little higher than 30% of the total number of 1001 teachers in the district [11]. However, only 126 (12.6%) teachers responded. The data collected from teachers were tabulated in Microsoft Excel spreadsheets and analyzed using descriptive statistics and presented in the form of graphs and tables according to the set objectives.

III. Results And Discussion

According to the literature, 'integrated science' had been introduced in 1972 for the first time in Sri Lanka at the junior secondary level to facilitate day to day life of people through the improved knowledge of science [9]. Three minor revisions were followed; in 1977 an additional technical subject was introduced as a life skill from grade seven to nine, in 1985 'introductory science' was

introduced to year 5 and in 1998 'science' was changed to 'environmental science' for the year six [6, 8]. The present major reform; student centered, activity based 5E learning cycle was introduced in 2006 [12]. The main objective of this revision was to improve the achievement level of science at the G.C.E. (O/L) examination at the year 11. This was a major change of the teaching and learning process as the whole method is based on the constructivist approach [2, 13] developed during the last century and practiced in the US education in 1980s. This is a student centered learning method and it has been tested for concept achievement levels [1]. However, the success depends on the multiple factors such as teacher's commitment and interest, availability of physical resources; teaching aids, laboratory equipment, sufficient working space, reference materials and access to internet resources etc., for the teaching–learning process [7].

The teacher survey revealed that almost all science teachers in the Kandy district are professionally qualified and that they have the required educational qualification as science.

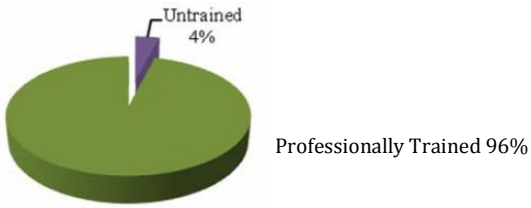

Figure 1: Status of professional qualified science teachers in the Kandy district

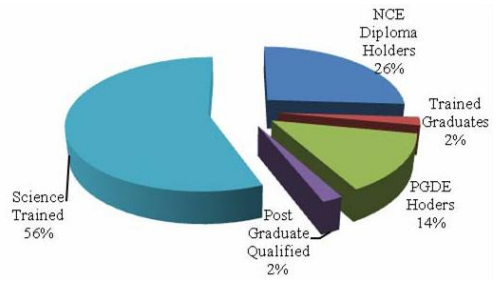

Figure 2: Different types of professional qualifications acquired by science teachers in the Kandy district

In addition 52% teachers have participated in more than 50% of the professional development training sessions for teaching science using 5E method offered by the department of education. On the other hand, about 80% have attended merely one training session. However, the student achievement levels of different schools in the Kandy district at the GCE/OL falls between the ranges of 4.5% to 100% with a mean value of 41% in the year 2009. The national level science achievement level was little higher than the Kandy district average of 48.3%. However, the national average had a sudden increase thereafter and reached 62% during 2010-2011 [4]. These results revealed that the science teacher qualifications are at a very high level but the student achievements are unsatisfactory. Further, the urban resourceful schools performed extremely well and reached 100% achievement level while the rural schools with limited resources had the lowest achievement levels.

According to the data, it was found that the teachers do not practice the 5E learning cycle in the way it is defined and the majority of them use various methods and combinations. It was found that only about 4% of the sample follows only the 5E method. There are only 8% of teachers who use one instructional method and out of them only 4% use the 5E method. The entire 92% use a combination of different instructional methods. Out of those who make use of these different methods, only 49% use the 5E method. It has been fully practiced only by 46% of them. 49% use the 5E method as a combination, and only 46% of them use it consecutively, step by step and correctly. using the five steps; Engagement, Exploration, Explanation, Elaboration and Evaluation in the proper manner while the vast majority (54%) follows other techniques in combination with some of the above steps. 54% of the above mentioned teachers do not use either the correct method or the correct order. Figure 3 illustrates the percentage use of individual steps of 5E by different teachers in teaching science. When the teaching methods are concerned, according to the above facts, only 8% use a single method including 5E and 92% of teachers use combinations of various methods; such as lecture method, discussions, demonstrations and discussions, project methods, group activities and individual discovery method etc. It was possible to identify a common combination method of 5E and the traditional teaching methods in which 58% of teachers replaced the second step Exploration with one of the traditional methods such as lecture method (10%) and teacher demonstrations (8.1%), discussions (6.4%), meaningful questioning (22%) and activities based on life experiences (11%), respectively.

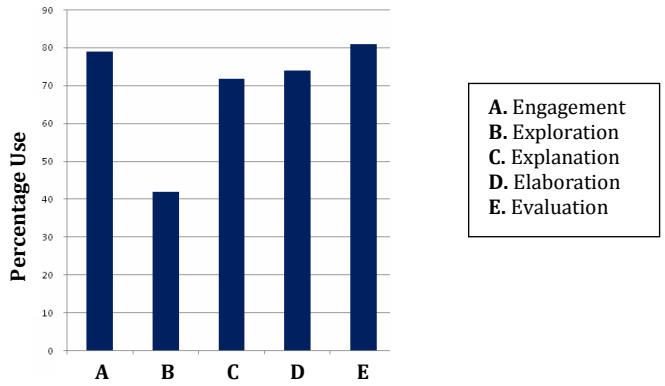

Figure 3: The practical usage of 5E steps by science teachers at the junior secondary level

This is a teacher adapted novel method of teaching combining both 5E and traditional methods. There is no such method defined in literature so far, practically used by the teachers. Although this modification deviates from the main objective of the learning cycle, this was found to be significantly effective in achieving physics based abstract concepts at grade six [10].

However, it is difficult to generalize the science concept achievement with this teaching method as this is the first year of changing students from traditional learning style to a student centered learning style and to get an exposure to new science concepts for the first time.

The teachers who are using the combined method of instruction stated that 5E method consumes fairly a longer time and that they cannot manage time to complete the syllabus. Further, due to lack of instruments and human resources in rural schools, too many students in some classes, poor

literacy of some students and individual differences of comprehension level are identified as the main challenges of implementing 5E method (Table 1).

Table 1: Problems faced by teachers in implementing recommended 5e method

5E method for concept teaching	Issues	Percentage
1	Poor cognition	25
2	Slow comprehension/Poor understanding	35
3	Poor Literacy	5
4	Monotony	1
5	Poor attention	3
6	Cannot be connected to practical experiences	10
7	Excessive Student number	1
8	Excessive subject content	1
9	Negative attitude towards learning	19

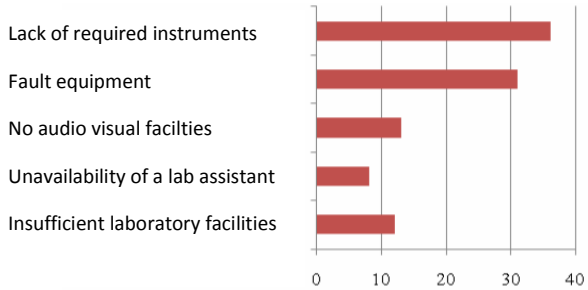

Figure 4: Physical and human resources limitations in science concept teaching at junior secondary level

IV. Conclusion

Science was introduced as a subject in the government schools four decades ago at the junior secondary level to facilitate the day to day life of future generations. Until 2006, teacher centered traditional teaching methods were introduced through three minor revisions. The latest major revision of science curriculum was done in 2006 and student centered 5E learning cycle method has been introduced at the junior secondary level. With all the reforms during last forty years, the science achievement level in the G.C.E. (O/L) examination in the Kandy district is about 41% in 2009 while the national average has gone up to 62% in 2010 and 2011. Although, the science teachers are professionally qualified to practice 5E in the district, the method is not successfully implemented at the ground level due to various practical limitations. To overcome the problems of time management and lack of facilities for implementing the 5E steps in the proper way, teachers have adapted a new method of instruction, identified as the 'combined method' of teaching by integrating 5E and traditional methods. The 'combined' teaching method is practiced by substituting traditional methods like lecture method, teacher demonstrations and discussion, explanation through questioning and explanation through environment based activities and for the step two (Exploration) of the 5E method. Therefore, the policy makers should pay proper attention on the feasibility of the practical implementation of new reforms at the school level and teachers' opinions should also be consulted.

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