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SRI LANKAN SENIOR SECONDARY STUDENTS' CONCEPTIONS OF LEARNING AND APPROACHES TO LEARNING SCIENCE: IS THERE ANY RELATIONSHIP?

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Abstract:
There has been a growing research during recent years on student related cognitive factors that associated with learning process such as conceptions of and approaches to learning. Students' conceptions as well as their learning approaches are considered as predictors of student performance. It is reported that the performance of Sri Lankan senior secondary students in the subject science is not satisfactory as expected. In this context, the analysis of their conceptions of learning and approaches to learning science provides important evidence in order to improve the performance level in students. This study was aimed to ascertain the relationship between Sri Lankan senior secondary students' conceptions and approaches to learning science. The Conceptions of Learning Science (COLS) questionnaire and Approaches to Learning Science (ALS) questionnaire were used to assess students' conceptions and approaches to learning respectively. The data was analysed using partial least square structural equation modelling (PLS-SEM). It was revealed that constructive conceptions of these students showed a positive relationship with deep learning approach. Conversely, a negative relationship was found between constructivist conceptions and surface approaches. The reproductive conception 'preparing for tests' showed a positive relationship with surface approaches to learning science. The results indicate that the learning approaches of these students can be predicted by their conceptions of learning. It provides an evidence that the meaningful learning approaches in these students can be promoted by developing constructivist conceptions in order to improve their performance in science. The findings provide important implications for curriculum developers, teacher trainers, teachers and students with respect to the improvement of science learning.

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Keywords: conceptions of learning, learning approaches, constructivist conceptions, reproductive conceptions, deep approach, surface approach, science learning

1. Introduction

In Sri Lanka like many other countries there is a great demand for science and technology skills due to the structural changes that are taken place in the economy (Jayawardena, 2015). High quality human resources with science and technology knowledge and skilled labour force are necessary to improve the country's global competitiveness. As a result, a special attention is needed to be paid by the education sector for promoting science education and harnessing creativity (Arunathilaka, 2015). The subject Science particularly at the secondary level is very important for students of the 21st century because secondary education is considered as the gateway to the opportunities and benefits of economic and social development. It is also known as the "keystone of education system" (Iftekhar, 2013). The results reflect students' achievement of learning outcomes through applying scientific knowledge and skills. An activity oriented teaching–learning methodology has been recommended for the school curriculum in Sri Lanka. Nevertheless, it is reported that there is a wide gap between the expected curriculum and the implemented curriculum due to the use of traditional lecture method by teachers. Similarly, the teaching-learning process is exam oriented which leads students to memorize the content focusing the examination. Nearly one third of the students are unable to obtain at least the minimum simple pass at General Certificate of Ordinary Level Examination which is the final evaluation after 11 years of education of a student (Department of Examination, 2017). Thus, it is essential to find the factors that affect the student performance in order to overcome the low performance level in science. Research has found that among numerous factors students' conceptions and their approaches to learning were found to be predictors of academic performances (Tarabashkina, 2011; Hemati Alamdarloo, Moradi, & Dehshiri, 2013). Moreover, research has revealed that conceptions of learning is associated with approaches to learning which in turn influence on their learning outcomes (Lee, Johanson & Tsai, 2008; Tsai, 2004). However, studies focused on such student related factors are limited in Sri Lanka which indicates the less attention paid by educational researchers on this regard. Thus, the present study aimed to ascertain the relationship between Sri Lankan senior secondary students' conceptions of learning and approaches to learning science.

2. Literature Review

2.1 Conceptions of Learning

Students' conceptions of learning are the views of students about their experiences and preferred way of learning (Liang & Tsai, 2010). It has been found that the students conceive the process of learning in different ways. The research on students' conceptions of learning was instigated over 40 years ago. The early research on

conceptions of learning was carried out by Saljo in 1979 who interviewed college students and identified five different conceptions of learning: "Increase of knowledge", "Memorizing", "Acquisitions of facts and procedures that can be retained and/or utilized in practice", "Abstraction of meaning", "Interpretative process aimed at the understanding of reality". After Saljo, several researchers studied on different groups of individuals and different contexts to categorize conceptions of learning based on the categorization of Saljo (Bahçivan & Kapucu, 2014). Tsai in 2004 interviewed 120 Taiwanese high school students to explore conceptions of learning science. The framework which was proposed included seven categories: "learning science as memorizing", "learning science as preparing for test", " learning science as calculating and practicing tutorial problems", "learning science as the increase of knowledge", "learning science as applying", "learning science as understanding", "learning science as seeing in a new way". These categories are sequenced in a hierarchical framework, from lower level to higher-level which indicates the shifting from traditional to constructivist conception on learning. The Conceptions of Learning Science (COLS) questionnaire was constructed by Lee and others in 2008 to investigate high school students' conceptions of learning in Taiwan (Lee, Johanson &Tsai, 2008). It was based on the study of Tsai (2004) and included six factors: "learning science as memorizing", "learning science as preparing for test", "learning science as calculating and practicing tutorial problems", "learning science as the increase of knowledge", "learning science as applying", "learning science as understanding seeing in a new way" (Bahçivan & Kapucu, 2014.; Tsai, 2000). Further, the conceptions of learning were identified in two types, constructive (higher level) conceptions and reproductive (lower level) conceptions. Three categories of conceptions namely 'memorizing', 'testing', 'calculate and practice' were considered as reproductive conceptions of learning while other conceptions namely 'increase of knowledge', 'applying', and 'understanding' and 'seeing in a new way" were included in constructivist conceptions (Tsai, 2004).

2.2 Approaches to Learning Science

Learning approaches refer to as how students perform learning, with their intentions (motives) and their methods (strategies) adopted for learning (Biggs, Kember & Leung, 2001; Ismail *et al*, 2013). Similar to the conceptions of learning, the concept 'approaches to learning' also has been evolved with the study of Marton and Saljo in 1979. Their study used phenomenographic method to ascertain qualitatively different ways in which students approach a reading task and they found a relationship between students' learning process and their level of understanding of the reading material. They have described two approaches to learning as surface level and deep level approaches which relates with their understanding of the reading materials. The surface approach defines the intention to reproduce information in a manner that is unreflective of the knowledge learned. When a student adopts surface approach to learning, it does not promote understanding or long-term retention of knowledge and information. The student tends to passively accept the content as isolated and unlinked ideas. In contrast, the deep approach involves the intention to understand knowledge in depth (Biggs &

Tang, 2007). In this approach, students has the intention of trying to understand really. They are able to remember the content through this understanding (McLoone and Afolabi Oluwadun, 2014). Therefore surface approach associates with a depleted level of understanding results in a poor learning outcome whilst deep level processing associates with a deep level of understanding and consequently a successful learning outcome. Educationists have been paid significant interest on these main two approaches resulted in numerous studies related to students' learning.

2.3 The relationship between conceptions of learning and approaches to learning

There are several studies which have explored the relationship between conceptions of learning and approaches to learning in different subject domains. Chiou, Liang & Tsai (2012) examined the relationship between students' conceptions of learning and approaches to learning in biology. It also aimed to identify gender differences in the relationship. The study sample included 582 undergraduate students who were biology related majors from 10 different universities across different geographical regions and different types of schools in Taiwan. This study was based on structural equation modelling. Two questionnaires, the Conceptions of Learning Biology (COLB) and the Approaches to Learning Biology (ALB), were administered to assess the conceptions of and approach to learning biology, respectively. The finding revealed that when the students possessed lower-level COLB, 'Memorizing', 'Testing', and 'Calculating and Practising', tended to adopt surface approach to learning in biology, while the students expressed higher level conceptions, 'Increasing one's knowledge', 'Application', and 'Understanding and seeing in a new way', they were more likely to adopt deep approach to learning in biology. Similar study focused on a different domain has been undertaken in Sri Lanka by Abhayawansa and Fonseca (2010). They explored students' conceptions of learning (SCL) and approaches to learning (SAL) of a group of students studying accounting in an Australian university. The study was based on the phenomenographic method and the focus was on the way that cultural background and home country learning experiences shape up SCL and SAL of these students. The data has been collected using semi-structured interviews. The results indicated that the students have lower-order conceptions of learning, and show characteristics of surface learning. Although the social approval motive was dominant in these students, it was not manifested in an achieving approach. Students in this study hold the pedagogical tradition of the West, and engage in deep learning when they exposed to research or practice-based assessments. The study reported that the remnants from years of secondary education and aspects of a collectivist culture play a vital role in the ways in which these students perceive and approach learning. This is a striking evidence for low quality and low rate in performance of secondary students in Sri Lanka.

A study aimed to explore the relationships among Taiwanese undergraduates' conceptions of, approaches to, and self-efficacy for learning earth science was carried out by Shen and others by adopting the structural equation modelling technique (Shen *et al*, 2016). The sample included a total of 268 Taiwanese undergraduates. Three instruments (conceptions of learning earth science (COLES), Approaches to learning

earth science (ALES), and self-efficacy for learning earth science (SELES) were modified to assess the students' conceptions of, approaches to, and self-efficacy for learning earth science. The lower level COLES factors (i.e. Memorizing, Testing, and Calculating and Practicing) tended to be positively correlated with the surface ALES (i.e. surface motive and strategy). The results also indicated that the higher level COLES factors (i.e. Increase in knowledge, Applying, and Understanding and Seeing in a new way) were positively correlated with deep approaches (i.e. deep motive and strategy). In contrast, the lower level COLES factors (i.e. Memorizing, Testing, and Calculating and Practicing) were positively correlated with the surface ALES (i.e. surface motive and strategy). The researcher suggested that earth science teachers should provide students with more learning experience of application, understanding, and getting new perspectives, and not over-emphasize 'Testing' in the earth science course. They also need to design an environment which encourages students to learn earth science with deep understanding and in a meaningful manner.

Above studies focused on the relationship between conceptions of and approaches to learning related to different domains and contexts. The findings of these studies indicate that, besides the domain and the context of learning, the students' conceptions of learning and approaches to learning are related.

3. Materials and Methods

3.1 Participants

The sample consisted of 415 secondary students (leading to General Certificate of Ordinary Level) from government schools in Western Province of Sri Lanka. Western Province represents comparatively highest number of senior secondary students (117,157) and it is nearly one third (28.4%) of total number of secondary Students in Sri Lanka. In addition, it represents all the school types of Sri Lanka. Stratified proportionate sampling was applied to select schools from each district and then from each school type. Students were selected from classes in each school using simple random sampling method. The sample consisted of 38.9 % male students and 61.1% female students. Considering the grade level, 47.6% of students were in Grade 10 and 52.4% of students in Grade 11.

3.2 Instruments

The approaches to learning science was assessed using ALS (Approaches to Learning Sicence) questionnaire and conceptions of learning science were measured by COLS questionnaire developed by Lee, Johanson, & Tsai (2008). The ALS was designed to be ranked by 5 point Likert type scale from rarely-1 to always-5. Similarly, COLS was also a 5 point Likert type scale but it was ranked as 'strongly disagree-1' to 'strongly agree-5'. These questionnaires were translated into Sinhala language using translate and back-translate method.

3.3 Data Analysis and Procedures

The present study is a cross sectional quantitative study. The data was analysed by applying the by Partial Least Square (Structural Equation Modelling PLS-SEM) method using Smart PLS(2). The analysis process included analysis of the measurement model and the structural model. Since it enables the researcher to analyse the relationships between several latent variables simultaneously the SEM approach was used in this study.

4. Results and Discussion

4.1 Analysis of measurement model

The measurement model of the study was analysed by determining internal consistency reliability, convergent validity and discriminant validity of the constructs. When composite reliability and Chronbach's alpha values are greater than 0.7 the internal consistency reliability is confirmed (Hair *et al*, 2014). In the present study, composite reliability as well as Cronbach's alpha values of all items was above 0.7 indicating the internal consistency reliability of all the constructs (Table 1). The convergent validity is the extent to which a measure correlates positively with alternative measures of the same construct which is indicated by the average variance extracted (AVE). Further, AVE is the degree to which a latent construct explains the variance of its indicators. On average, when AVE value is 0.5 or higher, the construct explains more than half of the variance of its indicators. Generally, it is recommended to remove indicators if the outer loadings are between 0.40 and 0. 70. However, the removal of indicators from the scale is recommended only if it increases the composite reliability and AVE values. (Hair *et al*, 2014).

Table 1: Quality criteria of the measurement model

Construct	AVE	Composite Reliability	R Square	Cronbachs Alpha
CA	0.73	0.91		0.88
CC	0.56	0.84		0.75
CI	0.65	0.90		0.86
CM	0.65	0.90		0.87
CT	0.65	0.90		0.87
CU	0.63	0.89		0.85
DA	0.56	0.83	0.22	0.73
SA	0.63	0.87	0.35	0.80

CA-Applying knowledge, CC- Calculating & Practicing
CI- Increasing knowledge, CM- Memorizing, CT- Prepare for test, CU- Understanding
DA - Deep Approach, SA-Surface Approach

In the present study outer loadings for 3 indicators were between 0.4 and 0.7 and removal of them resulted in increased AVE (AVE>0.5). As shown in Table 1 the AVE value for all the construct were greater than 0.5 which confirmed convergent validity.

The discriminant validity is the extent to which a construct is truly distinct from other constructs. The values are presented in terms of how much it correlates with other

constructs. It was determined by obtaining cross loadings (outer loadings on other constructs) of indicators (Hair et al, 2014). The outer loadings on the associated constructs were greater than all of its cross loadings. Hence, it can be considered that the discriminant validity of the constructs of present study was confirmed.

4.2 Analysis of the Structural Model

The structural model was analysed by bootstrapping method of Smart PLS-2 which uses 5000 re-sampling and as a result, path coefficients and t-statistics are calculated. The path coefficient (Beta value) represents the extent to which the exogenous construct is associated with the endogenous construct. The significance of the association is indicated by T-statistics (Hair et al., 2014). The critical values for a two-tailed test that are, 1.65 (significance level = 10%), 1.96 (significance level = 5%), and 2.57 (significance level = 1 %) (Hair et al, 2014). The T statistics and the path coefficients of the respective hypothesis are shown in Table 2.

Table 2: Results of Hypothesis Testing

Path	Path Coefficient (*p*)	T Statistics
CA -> DA	-0.03	0.52
CA -> SA	-0.22	3.22***
CC -> DA	0.06	0.93
CC -> SA	0.00	0.04
CI -> DA	0.23	4.42***
CI -> SA	-0.20	4.20***
CM -> DA	0.09	1.62
CM -> SA	-0.06	1.28
CT -> DA	0.02	0.36
CT -> SA	0.14	1.80*
CU -> DA	0.39	8.65***
CU -> SA	-0.26	5.83***

*** p<0.01 **p<0.05 *p<0.1;
CA-Applying knowledge, CC-Calculating & Practicing, CI- Increasing knowledge, CM- Memorizing, CT-Prepare for test, CU- Understanding
DA - Deep Approach, SA-Surface Approach

The conceptions about science learning as "applying knowledge", "increasing knowledge" and "understanding and seeing in new way" were negatively related to surface approaches. The results explain that when students viewed science learning as 'applying knowledge' they tended to adopt surface approach less frequently or rarely. Similarly, when they conceived science learning as 'increasing knowledge', they have used surface approaches rarely. Further, these students have applied surface approaches rarely when they developed conceptions of science learning as 'understanding and seeing in new way'. In contrast, these three conceptions have shown a positive relationship with deep approaches to learning science. It indicates that with these three conceptions, students have frequently adopted deep approaches. Furthermore, the conception "science learning is preparing for tests" was positively

related to surface approach. It explains that, with the development of conception about science learning as 'preparing for tests' students have tended to apply surface approaches more frequently. The results show that the constructivist or higher level conceptions of students are related to deep approaches to learning. Among reproductive or low level conceptions, only "preparing for tests" indicated a positive relationship with surface approach.

5. Recommendations

More-in depth studies using qualitative approach and also longitudinal studies can be recommended as future studies in order to investigate more about the relationship between conception of learning and approaches to learning science. Since the qualitative studies are in-depth studies spending more time using interviews and focus group discussions it will further elaborate the findings of the present study. Longitudinal studies can be conducted to discover any trend of relationship between conceptions of learning and approaches to learning science which takes place with the time. Moreover, the studies to find the gender differences are equally important. Since Sri Lankan population consists of different cultures, it is necessary to find the effect of the cultural difference towards this relationship. In addition, similar studies can be suggested to find teachers perception regarding conceptions of learning and approaches to learning science since they are the one of important factors regarding achievement of students. Researchers can be motivated for conducting similar studies discussed above for different subjects that reported lower achievement rate of students such as secondary level mathematics and English.

5.1 Conclusion

The present study has confirmed important relationships to provide implications for the improvement of science learning and teaching at the secondary level in Sri Lanka. Students' deep approach of learning is considered as a meaningful learning such as inquiry, evaluation, taking a broad view and relates ideas to one another. The present study showed a positive relationship between senior secondary students' constructivist conceptions and deep approaches to science learning. It can be further explained that the constructive conceptions such as "science learning is increasing knowledge, applying knowledge, understanding and seeing in new way" directed them to use deep learning approaches while the view that "science learning is to prepare for tests" which is considered as a reproductive conception has directed them towards surface approaches. The low quality performance level which is indicated by the lower percentage of students who obtained higher grades might be due to this surface learning. Sri Lankan school system is found to be exam oriented and students are highly competitive. Private educational institutes (tutors) are common and famous in Sri Lanka for each subject where the students are directed to practice for the examination paper. Besides the lectures conducted by the tutor, students hardly get the opportunity to perform the skills (practical activities) in these classrooms. Similarly, surface learning

is perhaps a reason for students' lack of scientific and innovative skills required for job market. The present study provides an evidence for the fact that students' constructive conceptions drive them to use deep approaches of learning more frequently. Thus, these conceptions should be developed in students in order to direct them for more meaningful learning.

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