RELATIONS OF G.C.E (O/L) STUDENTS' BIOLOGY SELF-CONCEPT AND MOTIVATION WITH THEIR ACHIEVEMENT AND MISCONCEPTIONS

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Abstract

Science education is important to maintain the quality of life in mankind. In Sri Lankan G.C.E. (O/L) science curriculum, Grade 10 and Grade 11 students should learn science. Past research has shown that students are poor in science subjects due to many inter-related factors such as teaching methods, students' academic abilities, students' interest, misconceptions, self-concepts, motivation and other psychological aspects. However, there is a dearth of research in the relations of students' biology self-concepts and motivation with their misconceptions. Thus, the purpose of this study is to investigate the relations of G.C.E. (O/L) students' self-concepts, motivation with their achievement and misconceptions in biology. This study was conducted in an educational zone in the Central Province, Sri Lanka. The sample consisted of 150 Grade 11 students and 12 teachers from three schools of the selected educational zone. The quantitative data were collected using the biology self-concept scale and biology motivation scale. The term test marks were used to explore students'

achievement. Quantitative data were analyzed by descriptive statistics, and regression. Qualitative data were analyzed by thematic analysis. In general, students' biology self-concepts and motivation were positively related to achievement and negatively related to misconceptions. The identified barriers to promoting biology in schools were; lack of students' motivation; lack of teacher training programs; lack of technology and the technological support to the lessons. Thus minimizing these barriers are important in increasing students' self-concepts, motivation and achievement. This will also help to reduce students' misconceptions to enhance science skills as well as science education within the country. The above findings could be used in planning and conducting the science lessons by integrating the new methodologies, technological support while facilitating a classroom with active learners which is better to enhance Science Education in Sri Lanka.

Keywords: Self-concept, Motivation, Achievement, Misconceptions

INTRODUCTION

Science is everywhere in the world. It is all around us and science education is important to maintain a quality of life in mankind. The science subject has been divided into biology, chemistry and physics for educational purposes. Thus, it would be better to improve the biological concepts of students to face future challenges well. Dissemination of knowledge and experience in biology takes place through various disciplines such as the origin of life, growth of organisms, evolution, functions of life and characteristics of the organisms in the biosphere. Further, biology is very important, since it gives attention to diseases, infections and causal agents of plants and animals, production of medicines, medical surgeries of several parts of the human body such as womb, heart, kidneys and brain to facilitate survival of living organisms. Moreover, biologists have found new agricultural food, medicines, plants and animal species that are more valuable to society.

Chandrasena, Craven, Tracey, and Dillon (2014) noted that biology education is very important to empower students' meaningful learning. Some students' engagement in biology lessons was not very satisfactory. Moreover, some students' achievement level in biology at school term test is at a low level. Past research suggests that there are positive relations with the student's self-concept and motivation with their achievement. However, there is a dearth of research on the relations of students' biology self-concepts and motivation with their misconceptions in Sri Lanka. Thus, this study had been aimed at investigating the relations of G.C.E. (O/L) students' biology self-concept, motivation with their achievement in a selected educational zone. Further, it had been aimed to investigate the relations of students' self-concept and motivation with their misconceptions in biology. This is a mixed-method study

where both qualitative and quantitative approaches were employed. The sample consisted of 150 Grade 11 students and twelve G.C.E. (O/L) science teachers. Data collection was conducted through questionnaires, semi-structured interview schedules and informal discussions. Data analysis was performed through SPSS 17.0 software package and thematic analysis. Finally, the findings of this study were used to make suggestions to enhance the students' of G.C.E. (O/L) biology education.

The Significance of Science Education and its Issues in Sri Lanka

Science is the field of study concerned with discovering and describing the world around us by observing and experimenting. According to study.com, science is the study of the physical and natural world through observations and experiments. Science is all around us. Right now, the fact that you exist and are in the process of reading this paper is science. Biologists study cells, genetics, anatomy and physiology of the body, evolution, and ecology. According to Sonnadeera (2011), Sri Lanka's future lies in developing human capital capable of delivering rapid growth in an acknowledge-driven global economy. Scientific literacy requires high-quality science education. In addition, a review and modification of the Grades 6–11 sequence plan is required to ensure that a sufficient amount of content is dispersed throughout the grades in order for pupils to be adequately prepared for the first national examination. Practical work, a distinct feature of science education receives little attention in the science curriculum for several reasons which are elaborated. According to the following figure of the data represented by Sonnadara (2011), the performance of students in Science at the G.C.E. (O/L) Examination by Province in 2009 shows somewhat low results in the central province.
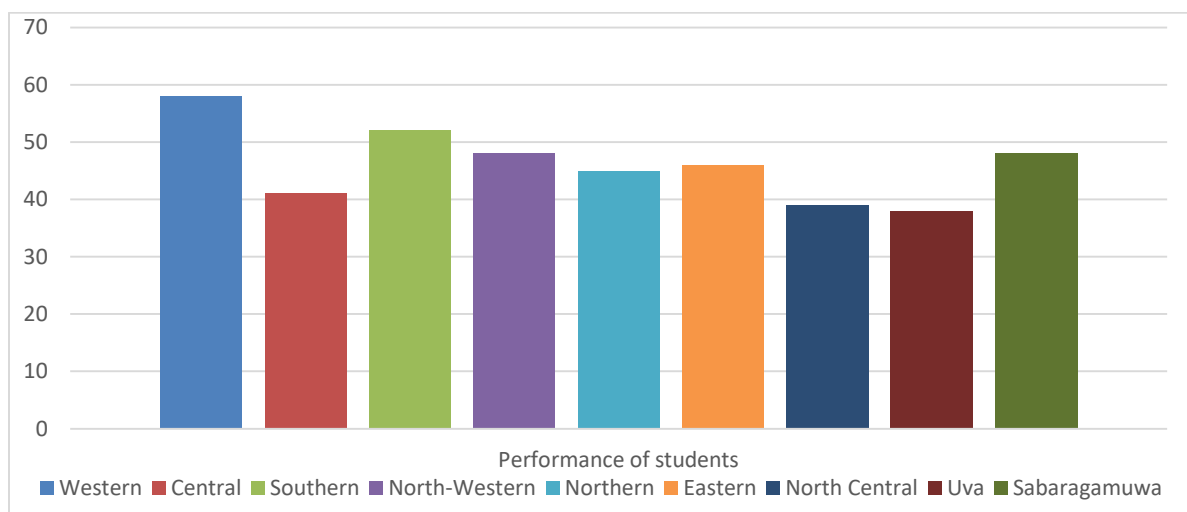

Figure 1. Performance of students in Science at the G.C.E. (O/L) Examination by Province, 2009.
Source: Sonnadara (2011)

Significance of Students' Self-Concepts and Motivation

One's self-perception is defined by one's self-concept, self-knowledge, self-esteem, and social self. One's self-concept (also called self-construction, self-identity, self-perspective or self-structure) is a collection of beliefs about oneself that includes elements such as academic performance, gender roles and sexuality and ethnic individuality. According to Zeyer & Wolf (2010), motivation is a theoretical construct used to explain behaviour. There are numerous benefits of having motivated Students in classrooms, increased quality and creativity, contributing to a better society. Motivation has been defined as "the internal state that arouses, directs, and sustains students' behaviour towards achieving certain goals" (Zeyer & Wolf, 2010, p. 2217).

Tella (2007) states that highly motivated students perform better academically than low-motivated students in mathematics. Moreover, academic achievement is highly correlated with students' motivation (Bank & Finlapson, 1980). Researchers have also discovered that pupils who are more motivated do better in school grades and other success outcomes, according to Pintrich (2003). Students' goal orientations have been investigated in more recent theories of school motivation. Seifert (2004) states that goal theory focuses on students' perceived goals and purposes for learning. The theoretical background of motivation is presented next.

Theories of Motivation

Expectancy and value constructions in social psychological theories of attitudes, intentions, and their relationships to conduct are the foundations of the theory of reasoned action and the theory of planned conduct. Expectancy is described as our views and attitudes about the future. More essential than the success or failure of activities that elicit pride or shame are the explanations of the attributes to the causes of success or failure (Werner, 1980). Thus, this theory explains why people behave in the way they practice. In his social cognitive theory, Bandura (2001) highlights two control systems in self-regulation of motivation, specifically a proactive discrepancy generating system that works in tandem with a reactive discrepancy reduction mechanism. As a result, people are motivated by the foresight of goals rather than the hindsight of shortcomings. As such, people use their effort and resources based on their anticipatory estimates for goal attainment. Models have recently emphasized the importance of objectives and goal orientation in explaining students' achievement patterns. Even if the goals aren't well-defined and can change with time, people have goals in mind that they want to achieve or avoid.

Students' Motivation in Science

The relationships between indications of motivation, such as academic goals and perceived ability, and outcomes, such as persistence and accomplishment objectives, have been studied. Students' poor performance and motivation are caused by a lack of ability and effort (Hidi & Harackiewicz, 2000). They also state that an absence of academic motivation and lack of interest influence students' neglect of their study. Children's scientific interests and attitudes decline as they get older (Eccles & Wigfield, 1992). Devetak, Lorber, Jurisevic, and Glazar (2009) discovered that students in Years 8 and 9 who had a greater level of Intrinsic Motivation to learn chemistry did not perform better. Male students had greater scores for motivation for science, self-concept of ability, and enjoyment of science than female students, despite the fact that female students had higher ratings for lack of worry (Hassan, 2008). However, due to the complex character of constructs, a complete research of motivation in several disciplines of research has not been done. As a result, the purpose of this study is to fill a vacuum in the research by evaluating students' motivation in biology and its relationship to their science accomplishment.

Significance of Achievement and Misconceptions

Isnian (2009) cites the collection of definitions about achievement in the education setting. Moreover, De Cecco and Crawford (1988) state that achievement is the expectancy of finding satisfaction in mastering and challenging in difficult performances. By finding out about a pupil's understanding at the start of a topic and establishing if there are any misconceptions (for example, believing that the moon only comes out at night) it is possible to plan to teach to challenge this idea and to shape future learning and understanding.

Research Objectives and Rationale

The relationship between students' self-concepts and motivation and achievement has been studied in the past. However, there is a dearth of studies in the relations of students' self-concepts and motivation with achievement and misconceptions in biology. Thus, this study focuses on narrowing the gap related to G.C.E. (O/L) biology education in the Sri Lankan context. The study aims to investigate the relations of G.C.E. (O/L) students' biology self-concept, motivation with their achievement and misconceptions to make possible suggestions to enhance students' biology achievement. The objectives of this research were as follows; a) to investigate students' biology self-concept, motivation, achievement and misconceptions, b) to investigate the relations between students' biology self-concept, motivation and their achievement and misconceptions, c) to investigate students' and teachers' perceptions on

G.C.E. (O/L) biology, and d) to make appropriate suggestions to enhance G.C.E. (O/L) students' achievement in biology discipline.

Past research has shown that many factors affect science education such as students' self-concept, motivation, teaching methods, students' abilities, available resources, and content of the syllabus. Understanding concepts and ideas in science, according to Aschbacher, Roth, and Li (2010), is a more and more valuable skill and experience around the world. Knowledge and appreciation of science is a valuable asset to have (Chandrasena et.al, 2013). However this research is investigating the relations of G.C.E. (O/L) students' biology self-concepts, motivation with their achievement and misconceptions to make possible suggestions to improve students' biology achievement.

RESEARCH METHOD

In this study mixed-method design was used. Thus, both qualitative and quantitative approaches were used in the data collection and data analysis. The convenience sampling technique was used for sampling. The student sample consisted of 150 Grade 11 students. These students were 16 years old. 12 teachers participated from all the schools that are teaching Grade 11 science. *Quantitative approach;* in the Quantitative approach secondary students' biology self-Concepts scale and biology motivation scale developed by Chandrasena, et al. (2014) were used in the study. Students' marks of the term test paper were used as the achievement of the selected students. A diagnostic test paper constructed by the researcher with peer reviews was used to collect information on students' misconceptions. *Qualitative approach:* in the qualitative approach semi-structured interview schedules for teachers and informal discussion schedules for students were used in the data collection. A consent form was used to create a printed version of the survey. With the help of school principals and teachers, appropriate days and times for school visits were arranged. The surveys were given out at the schools' science laboratories. The data gathering was done in a way that caused the least amount of disruption to usual schoolwork and scheduling. The students were given all of the essential instructions and information prior to conducting the survey. The students were informed at the start of the survey that the data obtained would be utilized solely for research purposes by the researcher.

Quantitative Data; quantitative data were analysed using SPSS 17.0 for descriptives such as mean values for the self-concept, motivation, achievement and misconceptions. Regression was used to find out the relations of independent variables of self-concept, motivation with the dependent variables, achievement and misconceptions to fulfill the research objectives. The proposed design of the path analysis of the study was as shown in figure 1.
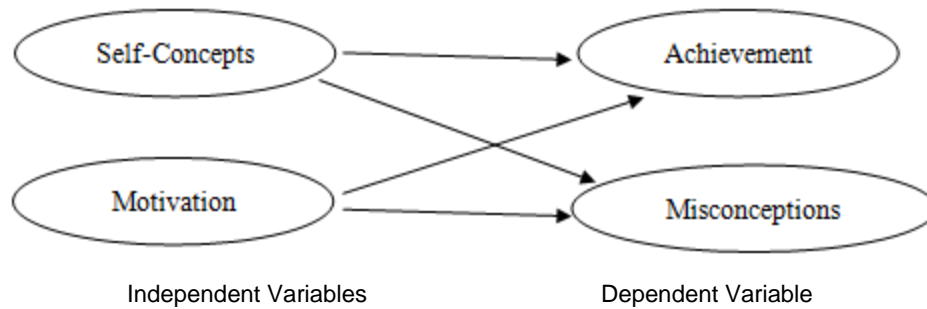
Independent Variables   Dependent Variable

Figure 1. Conceptual Framework

Qualitative Data; thematic analysis was conducted according to the semi-structured interviews of teachers and informal discussions with students. As the first step, all the qualitative data were transcribed after going through the records four to five times. According to the transcripts, open coding was conducted followed by first-order and second-order coding. This practice resulted in four themes at the end of the qualitative data analysis.

RESULTS AND DISCUSSION

The mean value of Self-Concepts of G.C.E. (O/L) students was 4.78 (Out of six on the Likert scale). The students have considerably higher Self-Concepts for biology. As biology is around us and related to our day to day practices, students' may love and are much familiar with the discipline of biology. However, still, students may have some problems in understanding some biology concepts.

Table 1: Highest and lowest self-concept estimates for the
total sample of the Self-Concept questionnaire

Mean Values for the Self-Concept	
Highest Mean value	5.39
Lowest Mean value	3.80

Motivation

The motivation of the selected students was high. According to the results, Mastery motivation is more important for the motivation of the selected sample of students (Table 2). It may be due to the establishment of their learning style such as visual (reading), auditory (listening) or kinesthetic (doing). Moreover, they might have asked questions and solved the problems within the classroom, had a chance to do hands-on activities along with good lesson notes and clear explanations of the subject matter. There had also been competitions among

the students. Further, the teaching and learning process had been integrated with the new teaching methodologies. However, Chandrasena, et al (2014) have found intrinsic motivation had the highest value among the above three types of motivation. This could be due to the lower sample size in this study.

Table 2: Motivation estimates for the total sample for the
Student Motivation: Mastery, Intrinsic and Ego orientations
(Out of six in the Likert scale)

	Mastery	**Intrinsic**	**Ego**
Average	4.9	4.8	4.7

Achievement

According to the results, more students in one school had very good marks than the other two schools. The G.C.E. (O/L) science results of the school mentioned above were 99% in the zone. Thus, their average marks were entirely different from the other two schools. Hence, overall results may have greater influence from the selected sample based on the available physical and human resources such as qualified science teachers, laboratory facilities, space, and books.

Table 3: Achievement estimates for the total sample for the
Achievement test/ school second term test

Achievement test Marks (%)	
Highest Mark	92
Lowest Mark	09
Average Mark	54.79

Misconceptions in Biology

Students show many misconceptions about the field of biology. The students' misconception rates according to the questions in the diagnostic paper. The following Table 4 indicates the intensity of different misconceptions held by G.C.E. (O/L) students' in the sample. Hence, some remedial measures have to be practised to support students to minimize their misconceptions.

Table 4: Misconceptions (MC) percentage (%) estimates for the

total sample for the diagnostic test Paper

Question No.	Total Sample	No. of MCs of Students	Misconception Percentage %
MC1	150	8	5
MC2	150	92	61
MC3	150	4	3
MC4	150	81	54
MC5	150	83	55
MC6	150	35	23
MC7	150	27	18
MC8	150	41	27
MC9	150	132	88
MC10	150	60	40
MC11	150	47	31
MC12	150	65	43
MC13	150	42	28
MC14	150	83	55
MC15	150	32	21
MC16	150	93	62
MC17	150	93	62
MC18	150	38	25
MC19	150	36	24
MC20	150	61	41

Relations of Self-Concepts and Motivation with their Achievement and Misconceptions

There is a positive relation between Self-concept and Achievement. Past research suggests a similar type of results. As biology is around us and related to our day-to-day practices, students' enthusiasm and enjoyment of the biological processes may increase self-concept while affecting the achievement. Thus, the results conclude that positive Self-concept may improve Achievement, as well as negative Self-concept, which may decrease the Achievement rate of the students. The finding agrees with the results of Visi (2015).
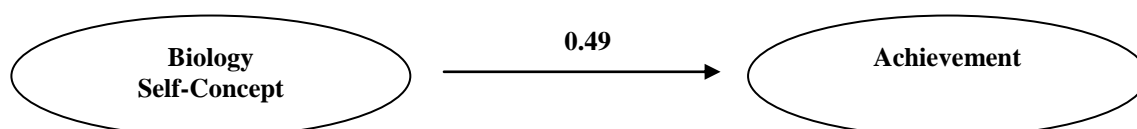
Figure 2. The relation between students' biology self-concept and their achievement

Moreover, there is a positive relation between Motivation and Achievement. Past research suggests a similar type of results. The results conclude that higher Motivation improves the Achievement level as well as lower motivation decrease Achievement.
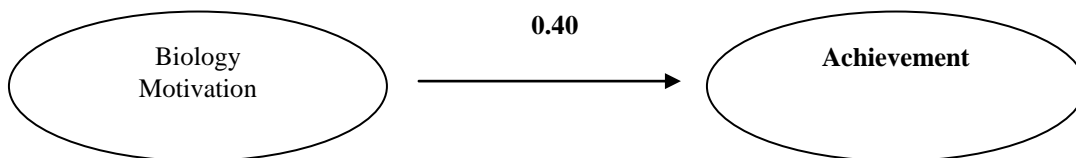

Figure 3. The relation between students' biology motivation and their achievement

The relation between Self-Concept and Misconceptions demonstrated a low correlation. Thus, the results conclude that higher Self-Concept may reduce the intensity of misconceptions in students.
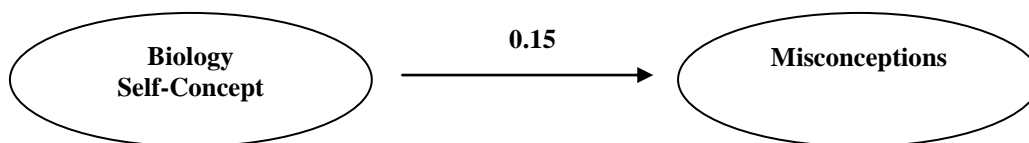

Figure 4. The relation between students' biology self-concept and their misconceptions

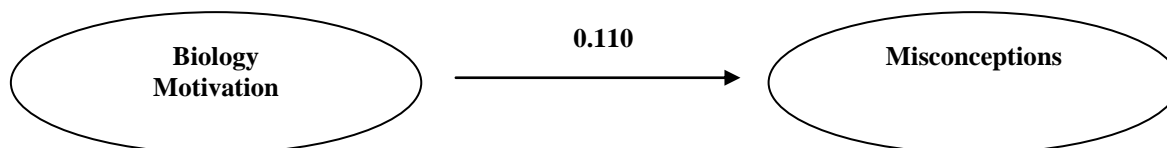Further, the results indicate higher Motivation may reduce the misconceptions.

Figure 5. The relation between students' biology motivation and their misconceptions

Qualitative Findings

A thematic analysis was performed on the qualitative data. (i.e., semi-structured interviews, informal discussions) obtained from the students' and teachers' perceptions on G.C.E. (O/L) Biology component identified barriers as follows. Therefore, these have to be addressed to enhance students' meaningful learning.
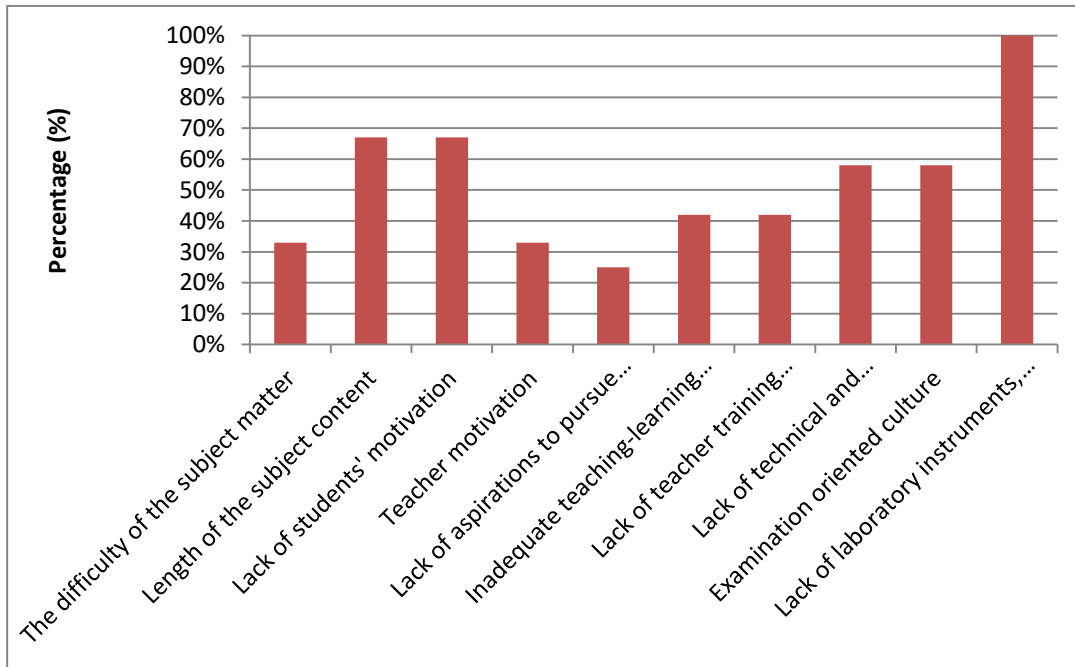
Figure 6. Barriers in the teaching-learning process of biology

According to the above results, the major barriers in the teaching-learning process of biology are lack of laboratory instruments, facilities, space and time; length of the subject content and lack of students' motivation (Figure 6). Moreover, all teachers highlighted that use of different teaching-learning methods would improve the teaching-learning process (Figure 7).
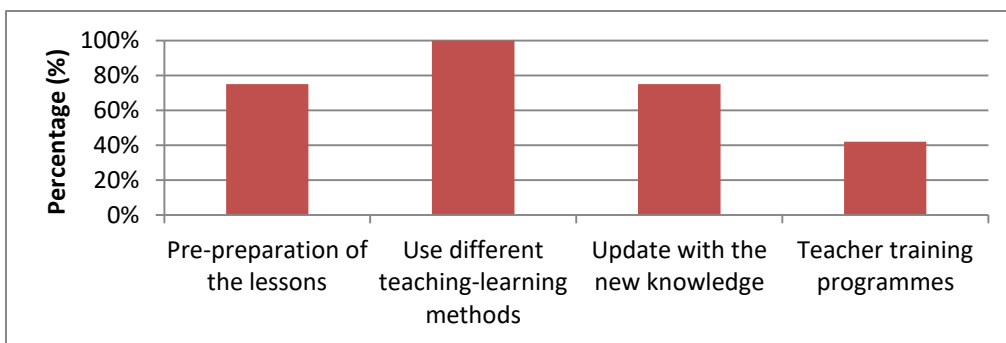

Figure 7. Teacher characteristics and teacher support on biology teaching.

CONCLUSIONS AND SUGGESTIONS

Past research suggested that there was a relationship between the Self-Concept and Motivation with Achievement and Misconceptions. The results of this research shows that the target group of students holds higher self-concept and motivation (Mastery, Intrinsic and Ego

orientations) in biology. Further, results show, there are relationship among G.C.E. (O/L) students' Self-Concept and Motivation with their Achievement and Misconceptions. Students' self-concepts and motivation promote their achievement whereas high self-concepts and motivation reduce students' misconceptions in biology. Teachers were in the opinion of improving students' Self-Concept, Motivation, and Achievement while reducing students' misconceptions related to the field of biology by changing the way of teaching, engaging new methodologies with the different lessons and using more practical work parallel to the lessons. Further, teachers face many difficulties in the teaching-learning process such as lack of technical and technological equipment, internet facilities, chemicals, laboratory equipment, space, time, managing a large syllabus, positive attitudes of students, parents, administration and policymakers. Changing attitudes will motivate them for better achievements. This confirm that the findings of Chandrasekara (2016), the attitudes change may lead for positive behavior. Students highlighted that they like to perform practical work to enhance their comprehension of the theoretical aspects.

Further, they like to work with technical instruments and new teaching-learning methodologies. The findings also reveal that education is a process of facilitating learning with a combination of human and physical resources such as teachers, educators, books and other learning materials along with appropriate teaching-learning methodologies. As students' high self-concepts reduce their misconceptions, classroom teaching should be conducted in the way of enhancing students' self-concept towards biology. Moreover, the learning environment should be suitable to boost students' motivation, as high motivation helps to decrease students' misconceptions. Different methods of teaching, student-centred learning environment, teacher support and appropriate assessment systems may help in minimizing students' misconceptions, which will eventually help to enhance students' achievement in biology. Thus, appropriate steps are to be taken to facilitate students to enhance their self-concepts and motivation.

LIMITATIONS OF THE STUDY

There are limitations in this study due to the small size of the sample, limited time duration, and the inclusion of a few concepts in the content of biology. Hence, a mass scale study has to be conducted by avoiding the above limitations to generalize the findings.

REFERENCES

Aschbacher, P. R., Li, E., & Roth, E.J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching*, *47*(5), 564–582.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52,* 1–26. https://doi.org/10.1146/annurev.psych.52.1.1.

Bank, C., & Finlapson, W. (1980). *Successful Motivation of Students in Academic Activities in McClelland*, D.C. Appleton-Century-Crafts.

Chandrasena, W., Craven, R. G., Tracey, D., and Dillon, A. (2014). Seeding Science Success: Psychometric Properties of Secondary Science Questionnaire on Students' Self-Concept, Motivation, and Aspiration. *Australian Journal of Educational and Developmental Psychology*,14, 186-201.

Chandrasena, W.D. (2013). Seeding Science success: Relations of secondary students'   ScienceSelf-Concepts and Motivation with Aspirations and Achievement.]PhD.   Thesis, University of Western Sydney, Australia.

Chen, Z., & Chandrasekara, W. S. (2016). The psychological mechanism of stigmatizing attitudes toward help seeking behavior for mental health problems. International Journal of Management, Accounting and Economics, 3, 720-734.

Chow, S.J. (2013). Secondary school students' motivation and achievement in combined science 1, 213-228. components of classroom academic performance. *Journal of Educational Psychology, 82,* 33–40.

De Cecco, J.P. & Crawford, W. (1988). *The Psychology of Learning and Instruction. Educational Psychology,* 2ed. New Delhi: Prentice-Hall of India Private Limited.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in   Human Behaviour*. NY: Plenum.

Devetak, I., Lorber, E. D., Jurisevic, M., & Glazar, S. A. (2009). Comparing Slovanian Year 8 and Year 9 elementary school pupils' knowledge of electrolyte chemistry and their intrinsic motivation. *Chemistry Education Research and Practice*, *10* (4).

Eccles, J. S., & Wigfield. A. (1992). The development of achievement-task values:

Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In N.Eisenberg (Ed.), *Social, emotional, and personality development in Handbook of child psychology,* 3 (pp. 1017–1096). New York, NY: Wiley.

Emily, R.L. (2011). Motivation in science, Available from: http://www.pearsonassessments.com (Accessed April 2011).

Harter (1978). Electronic Document Delivery – a trial in a sites.google.com. The Motivation and achievement in science. https://sites.google.com/site/motivationataglanceischool/competence-motivation.

Hassan, G. (2008). Attitude toward science among Australian tertiary and secondary school students. *Research in Science & Technological Education*, *26*(2), 129–147.

Hidi, S., & Harakiewicz, J. M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research*, *70*(2), 151–179.

Houghton Mifflin (2002). Electronic Document Delivery – a trial in an eduplace.com.

Institute of biology Sri Lanka (2017). Electronic Document Delivery -Importance of biology education. http://iobsl.org

Ionian, H.M.S. (2009). Electronic Document Delivery August 24. http://www.hmsofyanisniananapd.blogspot.com

Keogh, B. & Naylor, S. (2007). Electronic Document Delivery for learning science. HTTP:// scholar.google.com

Martin,A. J. (2003). Boys and Motivation. *The Australian Educational Researcher, 30,* 43-65.

McInerney, D. M. (1995). Goal theory and indigenous minority school motivation: Relevance and application. In P. R. Pintrich & M. L. Maehr (Eds.), *Advances in motivation and achievement, 9* (pp. 153–181). Greenwich, CT: JAI Press.

Oliver, J.S., (2015). The importance of Misconceptions in Science Teaching. University of Deusto(SPAIN).

Perles, C. (2004). Electronic Document Delivery – a trial in an   education in biology. HTTP:// education.seattlepi.com.

Pintrich, P. R. 2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational   Psychology, 95*(4).

Pintrich, P. R., & DeGroot, E. V. (1990). Motivational and self-regulated learning quality of school life. *American Educational Research Journal, 13,* 15–30.

Schunk, D. H. (1990). Introduction to the special section on motivation and efficacy. *Journal of Educational Psychology, 82*, 3–6.

Seifert, T. L. (2004). Understanding student motivation. *Educational Research, 46*(2),137–149.DOI: 10.1080/0013188042000222421

Senemoğlu, N. (2004). Gelişim öğrenme ve öğretim : kuramdan uygulamaya.

Sonnadara, U. (2011). Electronic Document Delivery –Strengthening Science Education in Sri Lanka, August 2011. http://www.academia.edu/2278684/Strengthening_Science_Education_in_Sri_Lanka

Tella, A. (2007). The impact of motivation on student's academic achievement toward school and subject matters. *Journal of Experimental Education, 48*, 18-23.

Visi, N. (2015). The Relationship between Students' Academic Self-Concept, Motivation and Academic Achievement 1, 270-276.

Werner, B. (1980). A Cognitive (Attribution)-Emotion-Action Model of Motivated Behavior: An Analysis of Judgments of Help-Giving, *Journal of Personality and Social Psychology*, *39*(2),186-200.

Wylie, R. C. (1989). *Measures of the self-concept*. Lincoln: University of Nebraska Press.

Yeung, A. S., & McInerney, D. M. (2005). Students' school motivation and aspiration over high school years. *Educational Psychology, 25*(5), 537–554.

Zeyer, A., & Wolf, S. (2010). Is there a relationship between brain type, sex and motivation to learn science? *International Journal of Science Education*, *32*(16), 2217–2233.