

Students' Motivation to learn Science and their Achievement in Science: How much it matters?

Nitu Kaur* and R. P. Vadhera**

Abstract

There is a strong felt need for motivated high school students to enter the postsecondary science stream. Students' science motivation have been found to decline as they move from post secondary years to higher education. To enroll students to various science courses we must understand what motivates them. The purpose of the present study was to determine how secondary school students conceptualized their motivation to learn science using the Science Motivation Questionnaire (SMQ II) as a survey instrument. The students' achievement in science course was measured through their term end board results of class X. The sample of students comprised of 1134(532 boys and 602 girls) secondary school going children of Aizawl district of Mizoram, India. All students were studying in schools affiliated to the Mizoram Board of School Education (MBSE). The findings of the study revealed that students were found to have above moderate level of science motivation and the mean science score of highly motivated group was found to be maximum indicating a favourable trait of science motivation within the students. Career motivation and grade motivation were found to be the strong motivational constructs by most of the students whereas students were least motivated by self-determination construct. Through differential analysis it was revealed that there exists a significant difference in the science motivation level of the high and low science achievers on all its five constructs with high achievers being more science motivated. Also significant difference exists in science motivational level in relation to gender with boys being more science motivated, however girls had higher mean motivation level for grade motivation. Also, no significant difference exists within the high and low achieving groups with regard to gender. This suggests that science motivation within secondary students can positively contribute to the achievement in science both in present and for choice of future career in science.

Keywords: Science Motivation, Achievement in Science

About authors:

Nitu Kaur* R. P. Vadhera **

(Department of Education, Mizoram University, Aizawl, Mizoram - 796 004, India)

The Indian educational system is suffering from the drawback of delivering science lessons in a very traditional outdated way that sometimes its importance in curriculum takes the back seat. The present picture of Indian schooling system is not very pleasing. Science teaching is suffering from the vacuum of conceptual clarities and that results in creation of many misconceptions, often so much to an extent that they are carried ahead sometime through higher education levels. There is a dearth of research and innovation in the field of science, both in the fundamental and the applied sciences. The present study is undertaken in the state of Mizoram, a very small state of North-eastern region with a unique cultural and ethnic diversity. Government data in the state are indicative that a very lesser percentage of students choose the science stream at senior secondary level in comparison to humanities (Mizoram Board of Secondary Education data). Also the problem of a number of

drop out students after studying science at senior secondary level needs to be addressed. Why is it so that most of the science students do not wish to continue their career in science? The question arises, whether they are afraid of science as it will be tougher at higher level or they are less motivated to take science as their career. The serious implications can be felt at the upper end in terms of low enrolment of students in higher education in the field of science. It is the pre-university stage where mindset of the students can be captured for motivating them to continue with higher education in science as this is the stage when differentiation and streaming of subject is introduced. By high school, students' motivation to learn science is one of the highest predictors of science course success (Britner & Pajares, 2006).

Motivation is a psychological construct which is associated with complying with certain set of needs of a being. In context of educational psychology it is widely studied as need of

achievement (n-Ach) also referred as achievement motivation. It has an association with narrow band personality theories (Peck & Whitlow, 1975). Atkinson & Feather (1966) developed the n-Ach theory and regarded n-ach as a motive which in combination with other variables can predict of one's behavior in a variety of setting. They found that the three important factors bearing upon one's success are i) one's degree of achievement motivation, ii) one's fear of failure and iii) the incentive or the value of the accomplishment to the individual. n-Ach is concerned with accomplishment, and how people vary in the degree that they are prepared to strive towards succeeding in competition at a particular standard of excellence (Peck & Whitlow, 1975). Pajares & Schunk (2001) found that students who are encouraged by parents favorably to explore and try different activities are found to be higher on their self-efficacy levels and are motivated to perform better academically. Favorable school environment and positive peer support are found to contribute equally to their self-efficacy level and they reflect positive behaviors such as improved class attendance and class participation, asking questions and seeking advice and participating in study groups. Brophy (2004) defines student motivation as "the degree to which students invest attention and effort. In general, motivation is the internal state that arouses, directs, and sustains goal-oriented behavior. In particular, motivation to learn refers to the disposition of students to find academic activities relevant and worthwhile; and to try to derive the intended benefits from them." Glynn, Aultman & Owens (2005) defined motivation in general as an internal state that arouses, directs, and sustains goal-oriented behavior. They further highlighted through their literature review that researches in past have been trying to employ various motivational construct in teaching learning contexts in order to motivate students to learn and it is hard to predict which of these constructs holds the best explanatory power. They categorized the reviewed construct mainly belonging to three categories, i) firstly, the constructs referring to students' traits and states, such as activity and anxiety level, interest, and curiosity together falling together in studies on comparison between intrinsic and extrinsic motivation to learn; ii) secondly the constructs

related to students' beliefs, such as self-determination, goal orientation, self-regulation, and self-efficacy; iii) and lastly constructs that refer to students' responses to others' expectations such as instructors, advisors and administrators. Betoret, Rosello & Gomez-Artiga (2017) suggested through their findings that expectancy-value beliefs of students which included their achievement expectations, value of the subject matter, process expectations with the teacher, expected cost to pass the subject are capable of satisfactorily explaining and predicting student achievement and their degree of satisfaction with the teaching process followed with a specific subject matter.

Studies exclusively focusing on science motivation started with efforts of Glynn and Koballa (2006) when they tried to develop an instrument named students' motivation towards science. It is believed that high science motivation levels within students seem to one of the vital indicators of high achievement in science. They developed a Science Motivation Questionnaire (SMQ) to measure students' motivation to learn science in college or high school courses using a 30-item Science Motivation Questionnaire to assess six components of students' motivation. These components are intrinsically motivated science learning, extrinsically motivated science learning, relevance of learning science to personal goals, responsibility (self-determination) for learning science, confidence (self-efficacy) in learning science, & anxiety about science assessment. The test has been found to reliable and valid. After this study several other studies came up trying to measure science motivation level in varied samples of population. Glynn, S.M., Taasobshirazi, G. & Brickman, P. (2009) in their study science motivation stated that "in studying the motivation to learn science, researchers examine why students strive to learn science, how intensively they strive and what beliefs, feelings, and emotions characterize them in this process." Glynn, Taasobshirazi, & Brickman (2009) tried to examine the motivation to learn science of non-science majors enrolled in a core-curriculum science course using Science Motivation Questionnaire, 30-item Likert-type instrument. An exploratory factor analysis suggested that the questionnaire has construct validity and the

students conceptualized their motivation to learn science in terms of five dimensions: intrinsic motivation and personal relevance, self- efficacy and assessment anxiety, self- determination, career motivation, and grade motivation. Glynn et al. (2011) tried to measure the science motivation by developing Science Motivation Questionnaire II (SMQ II) of science majors and non-science majors in American undergraduate students in order to assess the differences in the motivation to learn sciences, if it exists at all. Discipline specific versions are also available as Biology Motivation Questionnaire II (BMQII), Chemistry Motivation Questionnaire II (CMQ-II), and Physics Motivation Questionnaire II (PMQ-II) in which the words biology, chemistry, and physics are respectively substituted for the word science. The SMQ II assessed five motivation components: intrinsic motivation, self- determination, self- efficacy, career motivation, and grade motivation. They used the perspectives of social cognitive theory of Bandura highlighting the importance of environmental factors in human functioning. It was reported that the science majors were better on all the components of science motivation and in both science majors and nonscience majors, men had higher self- efficacy than women, and women had higher self- determination than men. This suggested that science motivation differs with the background i.e., their preference to choose science as major or non-major subject at undergraduate level. The study confirmed that SMQ II is a useful tool to determine science motivation of college students. Salta & Koulougliotis (2015) tried to adapt Science Motivation Questionnaire II (SMQ II) and made the Greek version of Chemistry Motivation Questionnaire II (Greek CMQ II) to investigate Greek secondary school students' motivation to learn chemistry for the first time. 330 secondary students (163 boys and 167 girls) belonging to lower (14-15 years) and higher secondary schools (16-17 years) were chosen for the study. Confirmatory analyses proved the Greek version to be reliable and valid. Gender based comparisons showed that girls had higher self-determination than boys in both the age groups and also the girls of lower secondary groups had higher career and intrinsic motivation than the boys of the same age group.

Science motivational studies are relatively new arena in the field of science education and are of far-fetching value in terms of improving the motivational constructs applicable in science teaching –learning processes.

Purpose and Objectives

The purpose of this study was to identify how secondary school students conceptualized their motivation to learn science. Further it was tried to compare the science motivation of students within the high and low achieving students in science. The researcher also sought to find the influence of gender on science motivation of students. Following are the objectives of the present study:

1. To describe and measure the conceptual factors that motivated secondary school students in science.
2. To compare the high and low achievers in science in relation to their science motivation.
3. To examine and measure the impact of the gender on science motivation amongst the secondary school students.
4. To find out the gender differences within high and low achievers in science in relation to their Science motivation.

Population and Sample

The population of the present study comprised of all secondary school students of Aizawl district of Mizoram. The chosen sample comprised of 1134 students (532 boys and 602 girls) of class X from 34 MBSE (Mizoram Board of School Education) affiliated schools in Aizawl district of Mizoram, India. All the MBSE affiliated secondary schools formed the population of the study. Stratified random sampling technique was used to pool out the sample.

Methods and Procedures

Present study is a descriptive study intending to measure the secondary students' motivation to learn science and differential analysis on this trait of motivation to learn science with special emphasis on achievement levels of students in science and their gender. The study used a correlational analysis to understand the relationship between gender and their level of motivation. The instrument used for the present

study was Science Motivation Questionnaire II (SMQ II) constructed by Glynn, Brickman, Armstrong & Taasobshirazi, 2011. The SMQ II is a revised version of SMQ (Glynn & Koballa, 2006). It was used to assess the science motivation level of secondary school students.

According to Glynn & Koballa, *motivation to learn science*, a social cognitive construct is defined as an internal state that arouses, directs, and sustains science-learning behavior. The SMQ II has five subscales each with five items measuring the dimensions of intrinsic motivation, self-determination, self-efficacy, career motivation and grade motivation. The questionnaire comprises of 25 items where students respond to each item on a rating scale of temporal frequency: never (0), rarely (1), sometimes (2), often (3) or always (4).

The raw scores should be interpreted carefully since the scale is ordinal. The possible score range of the 5-item scales is 0-20 making a total score range of 0-100. The items were randomly ordered as provided in online version of SMQ II © 2011 Shawn M. Glynn, University of Georgia, USA. Since SMQ II has been standardized on college students the score indicates what is "average" for undergraduate science majors and non-science majors at University of Georgia, it does not provide any classification criterion on the basis of obtained raw score. Only the magnitude of score can decide the degree of science motivation of students from

no science motivation to a very high science motivation. The efficiency of the scale is that it uses very simple, unambiguous, declarative, to the point focused questions on the motivation to learn science in courses rather than a multitude of contexts, such as hobbies and the Flesch-Kincaid formula indicates readability at the sixth-grade level (Glynn et al., 2011). Also the beauty of SMQ II is that it does not distinguish among different science subjects, but focuses on a general motivation to learn science (Chumbley et al., 2015).

The reliabilities (internal consistencies) of the scales, assessed by Cronbach's alphas, are as following in an order from highest to lowest: career motivation(0.92), intrinsic motivation(0.89), self-determination (0.88), self-efficacy (0.83), and grade motivation (0.81). The Cronbach's alpha of all 25 items was reported as 0.92 which a very good and reliable value.

The Science Motivation Questionnaire II is confirmed to have good content and criterion-related validity (Glynn, Taasobshirazi & Brickman, 2009; Glynn, Brickman, Armstrong & Taasobshirazi, 2011).

Findings

The first objective of this study was to describe and measure the conceptual factors that motivated secondary school students in science. Table 1 and 2 describe these findings.

Table 1
Conceptual Factors Motivating Students to Learn Science (n=1134)

Components/ Statements				
Intrinsic Motivation	Mean(0-4)	Median(0-4)	Mode(0-4)	SD
Learning science is interesting	2.99	3	4	1.06
I am curious about discoveries in science	2.56	3	2	1.24
The science I learn is relevant to my life	2.68	2	2	0.96
Learning science makes my life more meaningful	2.84	3	4	1.12
I enjoy learning science	2.63	2	2	1.14
Career Motivation				
Learning science will help me get a good job	3.29	4	4	1.07
Understanding science will benefit me in my career	3.17	4	4	1.09
Knowing science will give me a career advantage	3.16	4	4	1.10
I will use science problem-solving skills in my career	2.56	3	2	1.21
My career will involve science	2.61	3	4	1.29

Self Determination				
I study hard to learn science	2.57	2	2	1.10
I prepare well for science tests and labs	2.31	2	2	1.12
I put enough effort into learning science	2.16	2	2	1.09
I spend a lot of time learning science	2.09	2	2	1.07
I use strategies to learn science well	2.06	2	2	1.09
Self Efficacy				
I believe I can earn a grade of "A" in science	2.54	2	2	1.19
I am confident I will do well on science tests	2.28	2	2	1.09
I believe I can master science knowledge and skills	2.08	2	2	1.32
I am sure I can understand science	3.01	3	4	1.04
I am confident I will do well on science labs and projects	2.26	2	2	1.12
Grade Motivation				
Scoring high on science tests and labs matters to me	2.79	3	4	1.24
It is important that I get an "A" in science	3.07	4	4	1.19
I think about the grade I will get in science	2.75	3	4	1.12
Getting a good science grade is important to me	3.31	4	4	1.09
I like to do better than other students on science tests	3.06	4	4	1.09
SUMMATED SCORES				
	66.83	-	-	28.24

With reference to Table 1 it was found that students have moderate level of motivation to learn science with a summated average of 66.83 out of possible 100 score. It was found the largest motivators for students were grade motivation, specifically, the importance of getting an 'A' in science (M=3.07) and career motivation, believing that learning science will help him/her get a good job (M=3.29). The least common motivator was that of self determination, about being able to use

strategies to learn science well (M=2.06) and self efficacy, on believing that they can master science knowledge and skills.

Further with reference to Table 2, the highest motivational constructs were found to grade motivation with an average mean for the five items of 3.00 followed by career motivation (M=2.96), intrinsic motivation (M=2.74), self-efficacy (M=2.43) and self-determination (M=2.24).

Table 2
Motivational Construct Means

Construct	Mean (0-4)	Median(0-4)	Mode(0-4)	SD
Grade Motivation	3.00	3.6	4.0	1.15
Career Motivation	2.96	3.6	3.6	1.15
Intrinsic Motivation	2.74	2.6	2.8	1.10
Self Efficacy	2.43	2.2	2.4	1.15
Self Determination	2.24	2.0	2.0	1.09

The second objective of this study sought to compare the high and low achievers in science in relation to their science motivation. For the purpose of identifying the high and low achievers in the

sample the obtained class X MBSE board (block year 2016-2017) scores for students' science achievement were arranged in descending order such that marks were arranged from highest to

lowest. The upper 27% of the sample i.e. top 306 sample was identified as the high achievers and similarly the lower 27% of the sample i.e. the bottom 306 sample was identified as the low achievers.

The research questions guided to propose null hypothesis which is as follows:

Ho:-There is no significant difference between high and low achievers in science with respect to science motivation.

The science motivation scores of the two groups were subjected to differential analysis. For the testing of hypothesis student 't' test (independent sample) was performed (Table 3).

Table-3
Significance of Difference between High and Low Achievers in Science in Relation to their Science Motivation

Group	Number	Mean	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
High Achievers	306	72.327	13.484	.7708	10.68	610	S**	Rejected
Low Achievers	306	60.307	14.350	.8204				

*Source: Field data, **The test suggests that the difference between the two SDs is extremely significant at 0.01 level.*

Interpretation of data: A reference to Table 3 reveals that there is statistically significant difference between the mean science motivation scores of high achievers in science (M=72.327, SD=13.484) and mean science anxiety scores of low achievers in science (M=60.307, SD=14.350); the obtained t value (10.68) was found extremely significant at 0.01 level with degree of freedom 610, 't' critical value(2.576) being < obtained 't' value. It means that science motivation of secondary school students vary between low and high achievers. Hence the null hypothesis was rejected. The science motivation of high achievers is greater than that of low achievers which suggest that highly science motivated students tend to perform better in science.

An analysis was performed where the students' science motivation scores were segregated into five levels of motivation. The SMQ (Science Motivation Questionnaire) II by Glynn et al. (2011) does not specify the general science motivation levels as it is standardized on American sample but five motivational factors' can be classified into different levels of motivation. Students respond to each item on a rating scale of temporal frequency:

never (0), rarely (1), sometimes (2), often (3), or always (4). The possible score range on each of the five 5-item scales is 0–20. For an individual student, on any of the five 5-item scales, he or she can be put into a degree of science motivation by dividing their scale score (0-20) by 5. For example, a student with an intrinsic motivation scale score of 12 (out of 20) is "sometimes to often" intrinsically motivated $12/5 = 2.4$. A similar attempt to classify the total scores (range 0-100) into five levels of motivation was done. Five arbitrary categories of motivation scores were made such that 0 score mean absolute absence of science motivation, score range from 1-25 meant only low science motivation, 26-50 meant an average or moderate level of science motivation, 51-75 meant an above moderate level and 76-100 meant a high level of science motivation. There were no students with 0 score and the least score was of 12. There were only 5 students had science motivation score between 1-25. 148 students scored from 26-50, 653 students scored from 51-75 which were maximum followed by 328 students scoring from 76-100. The highest science motivation score was that of 100. (Table 4)

Table 4
Comparative Frequency Distribution of Students' Scores on Science Motivation

Classification	Score Range	No. of respondents	Percentage	Cumulative %
High Motivation	76-100	328	28.92%	100%
Above Moderate Motivation	51-75	653	57.58%	71.07%
Moderate Motivation	26-50	148	13.05%	13.49%
Low Motivation	1-25	5	0.44%	0.44%
No Motivation	0	0	0%	0%

Source: Field data

With reference to Table 4, it can be said that only 28.92% of the total students possess high science motivation and 57.58% of students possess above moderate level of science motivation together accounting for 86.5 % of the total students. This figure indicates that the sample population has an above average level of science motivation in general which is a very favorable condition for improving science achievement. There were no students with absence of science motivation and only five students possessed a low science motivation score. Nearly 13.05% students possessed a moderate level of science motivation.

A comparison of mean science scores of all the five categories of students segregated on the basis of their science motivation levels (Fig.1) revealed that students possessing low science motivation ($M= 54, SEM=3.317$) did not differed significantly ($P>0.05$) from any of the other groups. Rest three groups significantly differed ($P<0.001$) from each other in their mean science score. The mean score of moderate motivation group being the least ($M= 48.83, SEM=1.177$), the above moderate level had the second highest ($M= 55.92, SEM=0.5601$) and the high science motivation group had maximum mean science score ($M= 62.99, SEM=0.8083$).

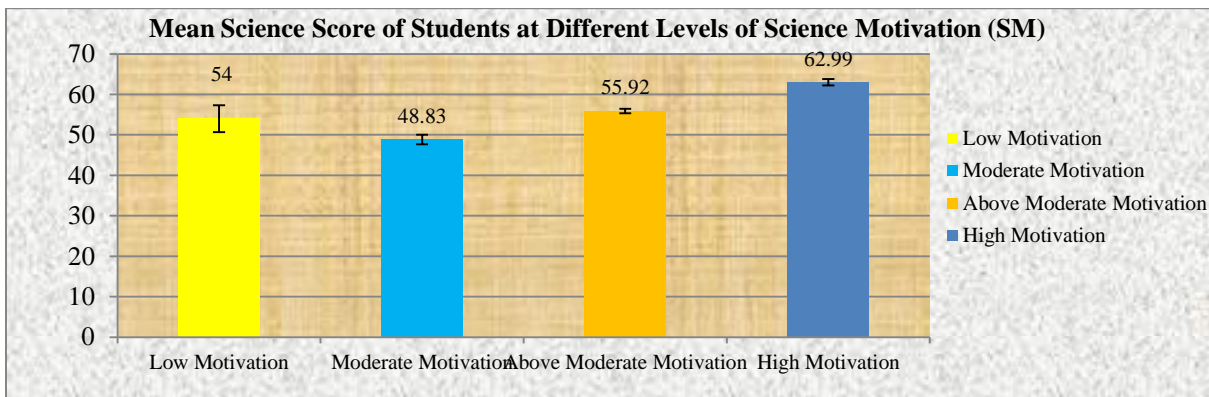


Fig.1: Mean Science Score of Students at Different Levels of Science Motivation (SM)

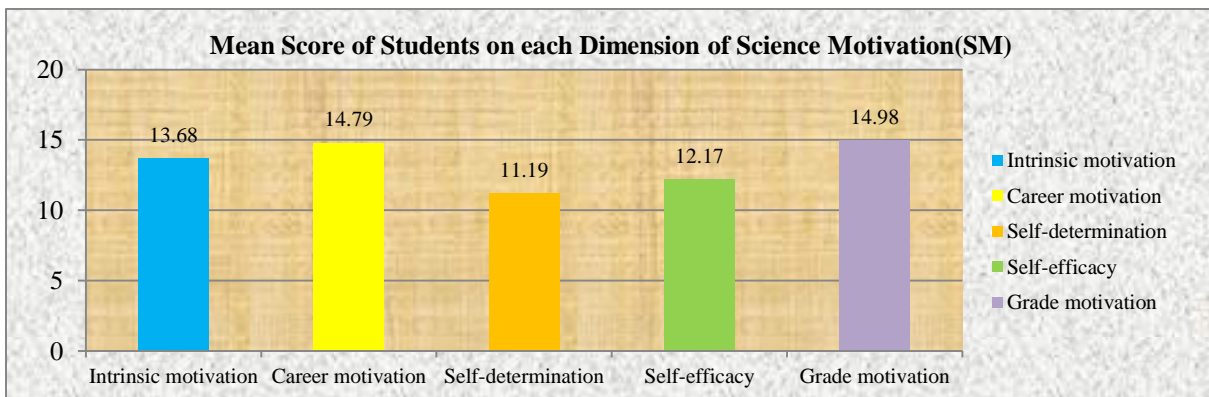


Fig. 2 Mean Score of Students on each Dimension of Science Motivation(SM)

A further analysis was performed where the students’ response on science motivation were categorized into five dimensions of the SMQ II. As already mentioned the scale comprises of five items under its each dimension ‘intrinsic motivation’, ‘career motivation’, ‘self-determination’, ‘self-efficacy’ and ‘grade motivation’. Each dimension is measured through 5 items with a score range of 0-20. It means minimum score obtained under each dimension can be 0 and maximum score can be 20.

Frequency distribution of the average score of students on each dimension of science motivation was analyzed using percentages (Fig. 2). The findings revealed that students scored maximum under ‘grade motivation’ dimension with mean value of 14.98 followed by ‘career motivation’, ‘intrinsic motivation’, ‘self-efficacy’ and minimum under ‘self-determination’ with mean value of 11.18. The comparative mean scores obtained on all the five dimensions are summarized in Table 5

Table 5
Mean Score of Students on each Dimension of Science Motivation

Dimensions of SM	Mean Score on each Dimension of Science Motivation
Grade Motivation (0-20)	14.98
Career Motivation (0-20)	14.79
Intrinsic Motivation (0-20)	13.68
Self-Efficacy(0-20)	12.17
Self-Determination(0-20)	11.19

To have more clear-cut understanding of the differences of high and low achievers in science in term of their science motivation, student t-test (independent) was performed to compare the high and low science achievers for their science motivation levels on each dimension. For the purpose of testing following null hypotheses were proposed.

Ho1:-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Intrinsic motivation'

Ho2:-There is no significant difference between high and low achievers in science with

respect to science motivation measured through the dimension 'Career motivation'

Ho3:-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Self-determination'

Ho4:-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Self-efficacy'

Ho5:-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Grade motivation'

Table 6 depicts the results of the hypothesis testing.

Table 6
Significance of Difference between High and Low Achievers in Science in Relation to their Means on Different Dimensions of Science Motivation

Dimensions	Groups	Number	Mean (M)	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
Intrinsic Motivation	High achievers in Science	306	14.56	3.497	0.1999	6.657	610	S**(0.01)	Ho1 Rejected
	Low achievers in Science	306	12.67	3.535	0.2021				
Career Motivation	High achievers in Science	306	15.91	3.754	0.2146	8.114	610	S**(0.01)	Ho2 Rejected
	Low achievers in Science	306	13.31	4.138	0.2365				
Self-Determination	High achievers in Science	306	11.98	3.670	0.2098	5.879	610	S**(0.01)	Ho3 Rejected
	Low achievers in Science	306	10.29	3.449	0.1972				
Self-Efficacy	High achievers in Science	306	13.23	3.719	0.2126	8.043	610	S**(0.01)	Ho4 Rejected
	Low achievers in Science	306	10.69	4.073	0.2329				
Grade Motivation	High achievers in Science	306	16.64	3.260	0.1864	11.575	610	S**(0.01)	Ho5 Rejected
	Low achievers in Science	306	13.25	3.950	0.2258				

Source: Field data, ** The test suggests that the difference between the two means is extremely significant at 0.01 level.

Interpretation of data: A reference to Table 6 shows that for all the five dimensions of SMQ II there is statistically significant difference between the mean science motivation scores of high and low achievers in science which are Intrinsic motivation [t(610)=6.657, p<.0.0001], Career motivation [t(610)=8.114, p<.0.0001], Self-

determination [t(610)=5.879, p<.0.0001], Self-efficacy[t(610)=8.043, p<.0.0001] and Grade motivation[t(610)=11.575, p<.0.0001]. In all the dimensions the high achievers in science differed significantly with higher mean science motivation score than those of low achievers. Hence **Ho1**, **Ho2**, **Ho3**, **Ho4** and **Ho5** were rejected.

The third objective of the study was to examine the gender variation in science motivation amongst the secondary school students. Here the main variable of concern in study is the student's science motivation at secondary level. Gender can be an important factor having its impact on students' motivation to learn science. In the present study the sample comprises of more girls than boys i.e. 602 girls and 532 boys i.e. 53.086% & 46.91% respectively which almost corresponds

to original population of data of secondary school students of Aizawl district (State year book 2014-15) which is 51.44% & 48.55% respectively.

The research question guided to propose the following null hypotheses:

Ho:- There is no significant gender difference in secondary school students with respect to their science motivation. Table 7 depicts the t-test analysis

Table-7
Significance of Difference between Boys and Girls in Relation to their Science Motivation

Group	Number(N)	Mean	S.D.	SEM	t value	Df	Significance of Difference	Decision on Null Hypothesis
Boys	532	67.938	14.854	.644	2.36	1132	S*	Rejected
Girls	602	65.895	14.282	.582				

Source: Field data. *The test suggests that the difference between the two means is significant at 0.02 level.

Interpretation of data:: A reference to Table 7 reveals that the obtained t value (2.36) was found significant at 0.02 level with degree of freedom 1132, 't' critical value(2.326) being < obtained 't' value. It means that science motivation of secondary school students vary with respect to their gender with boys being more

science motivated. Hence the null hypothesis is rejected.

Table 8 depicts the mean and standard deviation scores of students for different dimensions of Science Motivation Questionnaire (SMQ II) with regard to gender.

Table 8
Mean and Standard Deviation Values of Boys and Girls on Different Dimensions of Science Motivation Questionnaire

Factors of Science Motivation	Boys (n=532)	Girls (n=602)	Total (n=1134)
Intrinsic motivation	M=14.103	M=13.314	M=13.684
	sd=3.552	sd=3.532	sd=3.562
Career motivation	M=14.881	M=14.723	M=14.797
	sd=3.953	sd=3.976	sd=3.964
Self-determination	M=11.240	M=11.149	M=11.192
	sd=3.678	sd=3.511	sd=3.589
Self-efficacy	M=12.714	M=11.694	M=12.173
	sd=4.048	sd=3.834	sd=3.967
Grade motivation	M=14.951	M=15.015	M=14.985
	sd=3.910	sd=3.795	sd=3.848

A reference to Table 8 suggest that the mean scores of boys and girls on all the five dimensions of science motivation differed slightly with boys' average being slightly higher except for the dimension grade motivation where girls had higher mean score. Interestingly, the standard deviation for both boys and girls was almost neck to neck except for dimension self-efficacy where boys had higher mean score and standard deviation than their counterparts.

A further analysis was done using chi square test of association to identify the relationship between gender and students' levels on various levels of science motivation(refer Table 4 for various motivation levels)

Following null hypothesis was proposed for the purpose:

Ho:- There is no significant association between gender and level of science motivation.

The chi-square test of independence was employed to test the null hypothesis. Table 9 depicts the χ^2 analysis.

Table 9
 χ^2 results for Test of Independence between Gender and Level of Science Motivation

Group	High SM (76-100)	Above Moderate SM (51-75)	Moderate SM(26-50)	Below Moderate SM(1-25)	No SM (0)	Total	Level of Significance	Decision on Null Hypothesis
Boys	Obs. 175 (exp. 153.88)	Obs.298 (exp.306.35)	Obs. 54 (exp.69.43)	Obs.5 (exp.2.35)	Obs.0 (exp.0)	532	0.01	Rejected
$F_o - F_e$	21.12	-8.35	-15.43	2.65	0			
Girls	Obs.153 (exp.174.12)	Obs.355 (exp.346.65)	Obs.94 (exp.78.57)	Obs.0 (exp. 2.65)	Obs. 0 (exp.0)	602		
$F_o - F_e$	-21.12	8.35	15.43	-2.65	0			
Total	328	653	148	5	0	1134		
$\chi^2 = \frac{(F_o - F_e)^2}{F_e}$	2.89 + 0.23+3.43+2.99+2.56+0.20+3.03+2.65= 17.98* (df=4) $\chi^2=17.98$							

Interpretation of data: The chi-square analysis (Table 9) shows that science motivation is not independent of gender. The obtained chi-square value of 17.98 was found highly significant at 0.01 level at 4 *df*, ' χ^2 ' critical value (13.277) being < obtained χ^2 value indicating that there is a definite association between the different levels of science motivation and gender. Hence the null hypothesis was rejected.

Here, we see that both the 't' test and χ^2 analysis reveal that there is a significant difference between the science motivation of boys and girls. Interestingly all the students in below moderate level of science motivation having a score range of 1-25, were all boys.

Researchers also attempted to perform point bi-serial correlation between the variable gender and student's score on science motivation, which is a special type of Pearson product moment correlation considering the nature of variable. With reference to Table 11 it can be seen that science motivation and gender are negatively correlated i.e. higher level of science motivation is exhibited by lower number of group variable 'gender' which is 1 for boys and correspondingly girls with group variable 2 exhibited a lower level of science motivation. But at the same time the girls did not underperform badly compared to boys as the correlation is low negative, however significant at 0.05 level.

Table 10
Correlation between Science Motivation (IV) and Gender (DV)

Independent Variable(IV)	Dependent Variable	N	Df (N-2)	Point bi-serial Correlation	Significance level
Science Motivation	Gender	1134	1132	-0.07	S*

Source: Field data. **Significant at 0.05 level

The fourth objective of the present study was to find out the gender differences within high and low achievers in science in relation to their Science motivation

High and low achievers gender comparison was done using t test for the testing of following null hypotheses.

Ho1:-There is no significant difference in science motivation of high achievers with respect to gender.

Ho2:-There is no significant difference in science motivation of low achievers with respect to gender.

Table 11
Significance of Difference between Boys and Girls Within High and Low Achieving Groups of Science in Relation to their Science Motivation

Group	Number	Mean	SD	SEM	T value	df	Significance of Difference	Decision on Null Hypothesis
SM of High Achieving Boys	156	72.70	14.58	1.168	0.491	304	NS	<i>H₀₁</i> Accepted
SM of High Achieving Girls	150	71.94	12.27	1.002				
SM of Low Achieving Boys	120	61.26	14.25	1.301	0.931	304	NS	<i>H₀₂</i> Accepted
SM of Low Achieving Girls	186	59.69	14.42	1.057				

Source: Field data

Interpretation of data: A reference to Table 11 reveals that after the comparison between means on science motivation of boys and girls within the high achieving groups the obtained t value (0.491) was found not significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being > obtained 't' value. It means that there is no variation in science motivation of students within the high achieving groups with respect to their gender. Hence the null hypothesis (*H₀₁*) is accepted.

A similar comparison within the low achieving groups was also performed. Again with reference to Table 11 the obtained t value (0.133) was found not significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being > obtained 't' value. It means that there is no variation in scientific temper of students within the low achieving groups with respect to their gender. Hence the null hypothesis (*H₀₂*) is accepted.

Conclusion

The purpose of this study was to determine how the secondary students conceptualized their motivation to learn science, particularly those belonging to a close knit population of ethnic diversity in the north eastern state of Mizoram, India. When analyzing the conceptual factors that motivate the students to learn science, the highest motivational construct existed for grade motivation, followed by career motivation, intrinsic motivation, self-efficacy and least for self-determination construct. However difference existed between boys and girls with regard to their

motivational level through comparison of their mean scores, chi-square test of independence and correlational analysis all favors boys to be more science motivated. Exceptionally when compared on each of the five constructs, girls were found to obtain higher mean score for grade motivation than their counter parts. It suggests that girls are more motivated to obtain higher grades in science, which is also the highest motivational constructs that has impact on students high achievement in science. In general it could be concluded that external motivation factors of both obtaining good grades and good career in science propel students more to perform good in science than the internal motivational factors. The least motivating factor of self-determination and self-efficacy to perform good in science is indicative that science learning is least of an affective exercise and more of a mechanical sought where student's fail to build upon trust within them to do good in science. Science learning needs a more favorable environment where all kinds of fears and phobias need to be erased, in lack of which intrinsic motivational factors do not work.

From the findings of the present study it is revealed that the level of science motivation of secondary students in Mizoram is towards a higher range and it was found that they scored more than average in all the dimensions. They scored maximum for the dimension of grade motivation followed by career motivation, intrinsic motivation, self-efficacy and self-determination. The findings are in agreement with earlier studies (Bryan, Glynn & Kittleson 2011; Salta & Koulouglotis, 2015; Chumbley, Haynes & Stofer, 2015). It indicates

students are maximally motivated to perform better in sciences in order to get good grades, find a good career option and to some extent they have more than a moderate level of intrinsic motivation. However, the level of self-efficacy and self-determination are of average level, which needs to be improved further. It conveys a meaning that students are not self-motivated and confident for doing academically better in science which may be due to lack of some favorable environmental factors.

Recommendations

This study tried to show the gender differences in motivational constructs, majorly revealing dominance of boys in being highly motivated to learn science, but the study do not uncover a statistically significant correlation between motivational levels and their gender. In the present sample girls were found to be more than boys therefore unlike some of the dominant patterns of the country, in Mizoram gender parity has been very much achieved with girls' enrolment is greater than that of boys at high school level. It needs to be investigated further what kind preferences for learning science are sought by the students at secondary level of schooling with special emphasis on gender. Also additional research is needed in the area of enrolling more students to science stream and to investigate the factors that favors more boys to join the stream than their counterparts. What are the factors that are preventing girls from choosing science stream in future and how the science content should be organized that it could attract equal audience of both the gender? And why is so that students are moderately motivated to do science in their future endeavour? It is the pre-university stage where mindset of the students can be captured for motivating them to continue with higher education in science as this is the stage when differentiation and streaming of subject is introduced. The aspiring students who want to enter higher education in sciences need a befitting place where they can be accommodated smoothly. To bring up the scenario of science education in Mizoram it is essential to provide practical based science teaching to the learners. Practical based teaching does not implies simply increasing the number of period in timetable allotted for practical, but to ensure that student are able to

apply scientific method of thinking and are able to prove a particular theory by experimentation. Theory teaching need not to be a dry component in learning rather than the aim of theory teaching should be a well defined approach of teaching scientific method with a proper acquaintance to all stages of theory building. Knowledge of theory should not serve as a means to an end rather trigger critical approach and reasoning amongst the students. More opportunities of hands on instrumentation technique is to be provided to each learner in lab-work period and free time so that their hesitations and phobia towards science can be reduced. All developed societies are scientific societies and it is inevitable to escape from the need of motivating more and more students to the science stream.

Acknowledgement

The researchers want to acknowledge the contribution of Glynn et al. (2011) for giving permission to use the Science Motivation Questionnaire II (SMQ II) which was used in the present study for finding the science motivation of secondary school students.

References

- Atkinson, J. W., & Feather, N. T. (Eds.).(1966). *A theory of achievement motivation* (Vol. 66). New York: Wiley.
- Britner, S. & Pajares, F. (2006). Motivation in high school science students: A comparison of gender differences in life, physical, and earth science classes. *Journal of Research in Science Teaching*, 43(5), 955–970. doi: 10.1002/tea.20131
- Brophy, J. (2013). *Motivating students to learn*.Routledge.
- Chumbley, S. B., Haynes, J. C., & Stofer, K. A. (2015).A Measure of Students' Motivation to Learn Science through Agricultural STEM Emphasis. *Journal of Agricultural Education*, 56(4), 107-122.
- Doménech-Betoret, F., Abellán-Roselló, L., & Gómez-Artiga, A. (2017). Self-Efficacy, Satisfaction, and Academic Achievement: The Mediator Role of Students' Expectancy-Value Beliefs. *Frontiers in psychology*, 8, 1193.

- Glynn, S. M. & Koballa, T. R. (2006). Motivation to learn in college science. In J. J. Mintzes & W. H. Leonard (Eds.), *Handbook of college science teaching*, 25–32. Arlington, VA: National Science Teachers Association Press.
- Glynn, S. M., Aultman, L. P., & Owens, A. M. (2005). Motivation to learn in general education programs. *The Journal of General Education*, 150-170.
- Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science motivation questionnaire II: Validation with science majors and nonscience majors. *Journal of research in science teaching*, 48(10), 1159-1176.
- Glynn, S. M., Taasoobshirazi, G., & Brickman, P. (2009). Science motivation questionnaire: Construct validation with nonscience majors. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 46(2), 127-146.
- Pajares, F., & Schunk, D. H. (2001). Self-beliefs and school success: Self-efficacy, self-concept, and school achievement. *Perception*, 11, 239-266.
- Peck, D., & Whitlow, D. (1975). Approaches to personality theory. Methuen.
- Salta, K., & Koulougliotis, D. (2015). Assessing motivation to learn chemistry: adaptation and validation of Science Motivation Questionnaire II with Greek secondary school students. *Chemistry Education Research and Practice*, 16(2), 237-250.