STATUS OF SCIENCE EDUCATION IN MIZORAM: A CRITICAL STUDY

Thesis
Submitted in Fulfillment of the Requirement for the Degree of Doctor of Philosophy in Education

LYNDA ZOHMINGLIANI

DEPARTMENT OF EDUCATION
MIZORAM UNIVERSITY
AIZAWL
2011

MIZORAM UNIVERSITY

DECEMBER 2011

I, Ms. Lynda Zohmingliani hereby declare that the subject matter of the present thesis is a record of work done by me, that the contents of this thesis did not form a basis for the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University or institute.

This is being submitted to Mizoram University for the degree of Doctor of Philosophy in Education.

(PROF. B.B. MISHRA)	(PROF.R.P.VADHERA)	(LYNDA ZOHMINGLIANI)
Head	Supervisor	Scholar
Department of Education		

ACKNOWLEDGEMENT

With profound pleasure, I take this opportunity to acknowledge my gratitude to my Supervisor Prof. R. P. Vadhera, Department of Education, Mizoram University, Aizawl, Mizoram, for his invaluable guidance throughout the making of this thesis, sympathetic understanding of my shortcomings and tireless efforts that made this study presentable in the present form.

I am deeply indebted to the Head of my department, Prof. B.B. Mishra whose understanding and cooperation went beyond adminstrative duties. I shall remain ever so grateful to my senior colleagues Dr. Lalhmasai Chuaungo, Dr. H. Malsawmi and others who were a source of strength during my research. I also offer a deep sense of gratitude to my colleague Ms. Lalmuanzuali who was always there when I needed help. I am thankful to the supporting staff who were always willing to share their skills.

For a work of this size, the cooperation of a large number of individuals and educational institutions was necessary. In this regard, I am indeed grateful to the District Education Officers of the State, Statistical Cell: Directorate of School Education, Mizoram Board of School Education, Science Promotion Wing SCERT, Govt. of Mizoram, institutional heads and teachers who took pains to provide the best possible data. I am also grateful to their supporting staff who never hesitated to give me the right information at the right time.

My sincere thanks are also due to the Librarians: Mizoram University, NEHU, NUEPA, Jawaharlal Nehru University and NCERT for extending library facilities and lending their expert advice.

I offer my heartfelt gratitude to my loving family and friends. Without their support, understanding and motivation, this work would never have seen the light of day.

Last but not least, I am deeply grateful to the Almighty God for His presence from the beginning till the end of my study.

Dated Aizawl

The … December 2011

(LYNDA ZOHMINGLIANI)

Department of Education

Mizoram University.

CONTENTS

(vii)

List of Tables

List of Abbreviations

B.E: Bachelor of Engineering

B.Sc: Bachelor of Science

CBSE: Central Board of School Education

DSE: Directorate of School Education

HS: High School

HSS: Higher Secondary School

M.A: Master of Arts

MBSE: Mizoram Board of School Education

MIPOGRASS: Mizo Post Graduate Science Society

M.Sc: Master of Science

MSS: Mizoram Science Society

MZU: Mizoram University

N: Total Number

NCERT: National Council of Educational Research and Training

NEA: National Education Association (USA)

NEHU: North Eastern Hill University

P: Practical Class

PUC: Pachhunga University College

S&T: Science and Technology

SCERT: State Council of Educational Research and Training

SCORE: Science Community Representing Education

STAM: Science Teachers Association of Mizoram

T: Theory Class

TT: Total

CHAPTER - I

INTRODUCTION

"Who indeed could afford to ignore science today? At every turn we have to seek its aid… The future belongs to science and those who make friends with science".

- Jawaharlal Nehru.

1.0 Importance of Science Education:

Science and Technology in society has grown enormously over the past two decades and in our increasingly technological world, these subjects now affect most facets of our lives. Over the last twenty years, technological changes have been occurring at a particularly rapid pace and are likely to accelerate in the future. A country's level of development can be measured by the extent of 'skill' its people possesses for dealing with modern technology. It is common knowledge that a person needs training at least in basic sciences in order to be able to deal with modern gadgets. This is only possible through a period of learning in educational institutions.

The importance of science education in the modern world cannot be over emphasized. Science is an intensely human, intensely creative, enterprise. It dominates our lives and presents us with tremendous opportunities and challenges because there is no area untouched by it. The evidence of the correlation between science and technology and economic or industrial development is overwhelming. Science discovers new knowledge and technology utilizes this new knowledge to produce better and more useful materials that make living easier and safer. When technology is applied in industries and other areas pivotal to a country's progress, even poor feudal type economies can be transformed into industrial and economic power houses. Countries like China and Europe are one of the many countries that have only science to thank for their incredible growth and development. Therefore a sound understanding of science and its power is crucial for all.

At the individual level, a person's understanding of science enables him to make the right life choices and deal effectively with his surroundings. The world we live in is a highly technological world and it is imperative that each individual be enabled to survive in such a world. His or her view of the world, ability to make use of new technology in private and professional life as well as appreciation of healthy living are all shaped by scientific knowledge. Science education not only helps the individual to adapt well but also enables him to understand his own impact on his environment and thus inspires him to live responsibly.

At the societal level, science has been and has continued to be the driving force that has the ability to raise a simple society to one that is complex and driven by science and technology. Bandura (1997) asserts that teaching efficacy is *of particular concern, given the importance of scientific literacy and competency in the technological transformations occurring in society*[1]. The application of science and technology has transformed societies through dramatic advances in almost all fields including medicine, engineering, electronics, aeronautics etc. and in more recent times dramatic leaps in computer technology have revolutionised in particular the information and communications sector. Therefore, a society that refuses to accept the importance of science and technology will not be able to survive for more than a few years. This is only possible through sound science education beginning at the primary level and continuing through higher education.

A nation's problem of hunger and poverty, illiteracy and insanitation, superstition and dying customs and traditions along with wasted resources are not above science to solve. A look at different countries all over the world clearly proves the importance of scientific knowledge. The richest countries of the world are not necessarily countries with abundant natural resources but ones that make good use of science and technology. On the other hand, there are a number of countries that are rich in mineral and other natural resources but still lag behind other countries in growth and development due to their refusal to make use of science and technology. Therefore, scientific knowledge is even more important

[1] **Bandura, A. (1997)**. *Self-efficacy : the exercise of control*. New York: W.H. Freeman.

for the realization of a country's growth potential rather than the availability of material resources.

Thus, the importance of science and technology in today's world is overwhelming and therefore the education system throughout the world has to gear itself to provide the required training in scientific skills to meet this growing challenge. Scientific skills does not merely mean the accumulation of numerous scientific facts but rather the content of science curriculum, the amount given to the teaching of science and the method of teaching science at various levels. Therefore, an in depth study of the status of science education becomes necessary so as to understand its true nature, identify discrepancies if they exist and give it the desired enrichment in order to make it more meaningful and relevant.

1.1 The meaning of Science:

The real reason why science has become so vitally important in every field may be understood only after a thorough understanding of what Science is. As such, an attempt has been made in the following lines to give a better understanding of Science.

Science, from the Latin *Scientia,* meaning 'knowledge' is a systemic enterprise that builds and organises knowledge in the form of tables, explanations and predictions about the universe[2]. The **Columbia Encyclopedia** defines science as '*An accumulated and systematised learning, in general usage restricted to natural phenomena*'[3]. Others define it as what scientists do. Still others stress that it is far easier to experience science (like life) than define it.

It should also be kept in mind that science has a historical past, i.e., it is also cumulative in nature. Scientists have built the present day body of scientific knowledge by basing it on each other's work right throughout its history. The educational implication of this is that we should frequently help children crawl

[2] http://en.wikipedia.org/wiki/Science

[3] **The Columbia Encyclopedia**, Sixth Edition, Columbia University Press; 2009

upon the shoulders of giants by making use of relevant instructional and illustrative material suitably related to their mental development.

Beyond mere precise definition, what is more important is to see what science includes, and the following are of fundamental importance in the approach to this subject:

(i) Direct and indirect observations,
(ii) Scientific inquiry – asking questions,
(iii) The drawing of inference from evidence,
(iv) Recording observations,
(v) Developing ways and means to find answers, and
(vi) Classifications and checking evidence.

Thus the content of science is limitless. The question is not just about the slice of content which is to be taught. What is more important is how a particular content is linked to scientific literacy, citizenship training and economic development rather than how recent it is.

1.2 Development of Science Education:

1.2.1 Development of Science Education in the World:

Throughout history, man has been involved with the pursuit of scientific truth. Even before formal education was popularised around the world, early Greek philosophers like Socrates, Plato and Aristotle were already known for their love of truth. But it was only their few students who could reap the benefits of their knowledge. What the world knows today of their knowledge may only be a small amount that their students could pass on based on their memory. As time went by, formal education began to be appreciated as a convenient means of training children and centuries later, public schools began to make their appearance in the civilized countries. In tracing the development of Science Education in the world, one cannot but mention the two countries most cited in terms of human development- The United Kingdom and United States of America.

In the United Kingdom, the first person credited with being employed as a Science teacher in a British public school was William Sharp who left the job at Rugby School in 1850 after establishing Science to the curriculum[4]. Sharp is said to have established a model for Science to be taught throughout the British Public Schools. The next step came when the British Academy for the Advancement of Science (BAAS) published a report in 1867 (Layton, 1981). BAAS promoted teaching of "pure science" and training of the "scientific habit of mind". This rather slow step was mainly due to the absence of qualified teachers in science.

The development of a science curriculum in the US emerged gradually after extended debate between two ideologies, citizen science and pre-professional training. Science Education was a scatter of subjects prior to its standardization in the 1890's as a result of a conference of 30 leading secondary and college educators in Florida. The National Education Association appointed a Committee of Ten in 1892 which had authority to organize future meetings and appoint subject matter committees of the major subjects taught in U.S. secondary schools. The committee was composed of ten educators (all men) and was chaired by Charles Eliot of Harvard University. The Committee of Ten met, and appointed nine conferences committees (Latin, Greek, English, Other Modern Languages, Mathematics, History, Civil Government and Political Economy, and three in science). The three conference committees appointed for science were: physics, astronomy, and chemistry (1); natural history (2); and geography (3). Each committee, appointed by the Committee of Ten, was composed of ten leading specialists from colleges and normal schools, and secondary schools. Each committee met in a different location in the U.S. The three science committees met for three days in the Chicago area. Committee reports were submitted to the Committee of Ten, which met for four days in New York, to create a comprehensive report (NEA, 1894). In 1894, the NEA published the results of work of these conference committees (NEA, 1894). Since then, the United States

[4] http://en.wikipedia.org/wiki/History_of_education

of America has been utilizing a curriculum for science that may be characterized as follows:

- Elementary science should focus on simple natural phenomena (nature study) by means of experiments carried out "in-the-field."
- Secondary science should focus on laboratory work and the committees prepared lists of specific experiments
- Teaching of facts and principles
- College preparation

A look at other countries also revealed that Science Education should be a combination of theory and practical work at least from the secondary stage onwards.

1.2.2 Development of Science Education in India:

Though science has always been accepted as an important subject in the country, its real worth was only officially recognized in 1948 by the Radhakrishnan Commission which recommended for special science laboratories to be set up in different parts of the country. Following this, the Mudaliar Commission stressed on the importance of introducing courses with a vocational bias. The Kothari Commission (1964 – 66) also recommended upgrading of Science curriculum, pre and in-service programmes for teachers and strengthening agencies of the state that take care of science education. The National Policies of Education – 1968 and 1986 have also advocated science as a major tool to accelerate the growth of national economy. The recommendations of these Commissions clearly show that India wants its people to be 'scientifically literate'.

'*The key to the national prosperity, apart from the spirit of the people, lies in the modern age, in the effective combination of three factors: technology, raw materials and capital, of which the first is perhaps the most important, since the creation and adoption of the new scientific techniques can, in fact, make up for deficiency in national resources, and reduce the demands on capital. But* *technology can only grow out of the study of science and its application*'[5]. So says the Scientific Policy Resolution of India enunciated on 4 March 1958, which was Nehru's Magna Carta for the development of science in the country. Among other things, it aimed to:

- foster, promote, and sustain by all appropriate means, the cultivation of science and scientific research in all aspects – pure, applied and educational.

- secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

Further, with a view to guiding the course of development of Science &Technology in the country, the Government of India enacted several policy declaration, at the national level, such as:

- ***The Technology Policy Statement* in 1983** which clearly stated that 'The use and development of technology must relate to the people's aspirations. Our own immediate needs in India are the attainment of technological self-reliance, a swift and tangible improvement in the conditions of the weakest sections of the population and the speedy development of backward regions'[6]
- ***The Industrial Policy Resolution* in 1946, 1956,….1991** which has repeatedly stressed on rapid industrialization of the whole country while undergoing modifications over the years. The Industrial Policy Resolution 1991 clearly stated that its objective was to maintain sustained growth in productivity, enhance gainful employment and achieve optimal utilization of human resources, to attain international competitiveness and to transform India into a major partner and player in the global arena.
- ***The New Education Policy 1986*** strongly demanded that with a view to accelerating the growth of the national economy, science education and research should receive high priority. Science and mathematics should be an integral part of

[5] **Health Research Policy**; IMCR Bulletin; Vol.34, No.9-10; September-October, 2004.
[6] **The Technology Policy Statement**; Ministry of Science and Technology; Govt. of India, 1983.

general education till the end of the school stage. In chapter 8, *The New Education Policy 1986* clearly stated the importance of promoting science as follows:

- *Science education will be strengthened so as to develop in the child well defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question, and an aesthetic sensibility*.

- *Science education programmes will be designed to enable the learner to acquire problem solving and decision making skills and to discover the relationship of science with health, agriculture, industry and other aspects of daily life. Every effort will be made to extend science education to the vast numbers who have remained outside the pale of formal education.*[7]

Besides these, a number of policies at the sectoral levels have been adopted, in recent years, making an impact on the performance of Science and Technology in the country e.g. policies for energy, electronics, computer and telecommunication, minerals, drugs and health, water, housing, chemicals and fertilizers, patents and copyright, etc. The existence of the nature of Acts for the promotion and protection of Science and Technology can be taken as an indication of the national commitment to the development of Science and Technology for the economic growth of India. However, all these Acts and policies have meaning only when the citizens begin to understand and appreciate them. This is possible only through a sound science education system that should begin from elementary stage and continue till the apex of formal education.

1.2.3 Development of Science Education in Mizoram:

The pioneer Missionaries Rev. J.H.Lorrain and Rev. F.W.Savidge arrived in Mizoram on 11th January 1894. They soon took over education, formulating a new alphabet for the Mizos and how to read and write. According to the 2nd Report of the Committee on Estimates, Mizoram Assembly (1975-77) the two pioneer Missionaries started teaching at Aizawl in 1895, utilising a Church Building built by themselves as a School that was the first regular teaching

[7] The New Education Policy 1986; Ministry of Human Resource Development; Govt. of India, 1986.

institution in Mizoram. Education spread and this resulted in the condemnation of the 'Zawlbuk', an informal system of education where young boys were taught about the Mizo culture. In fact, since having a job in the government began to have more importance, the Mizos began to favour schools where they could get the formal training needed to get government jobs. As indicated in the Table-1.1, schools from primary and above have been steadily increasing in the land. There are some years where the number seems to go down but this is only because some privately owned schools often failed to report themselves to the Directorate. Even during these years enrolment was always on the increase.

1.2.3.1 Development of Elementary Education:

Although elementary education was not a part of this study, they have to be considered while studying the growth of science education because without this stage it would be impossible to go up the ladder in formal education. A separate School building was constructed at Aizawl in 1879. This was the first educational building ever seen in Mizoram. As revealed by the 1901 census, the number of literates out of total population of 82,434 were 761 (736 males and 25 females). In 1903 the first Lower Primary Examination was held. Out of 27 candidates 19 came out successful in this examination. From then on, primary education began to spread all over the state. As indicated by Table-1.1.0, during the year 2009, there was a total of 1782 schools providing primary education and 1313 schools providing middle school education.

1.2.3.2 Development of Secondary Education:

It was only in 1945 that the first High School was established and this was soon taken over by the Assam State Govt. Prior to this, in the year 1935, another high school had been opened in Kulikawn area within the town of Aizawl but this was closed soon after it was opened. The first high school was in Aizawl and was aptly called Mizo high school. This was followed by another school in Lunglei called Lunglei High School in the year 1947, a year after India gained independence from the British administration. Soon after, in the year 1950, another school called Gandhi Memorial high school, was opened in Champhai town. From then on, secondary schools were being opened almost on a yearly basis, some by private initiative and some as part of government plan.

Table- 1.1
Growth of schools in Mizoram

Year	P/S	M/S	H/S	H.S.S	Year	P/S	M/S	H/S	H.S.S
1894 (Beginning)	1	Nil	Nil	Nil	**1990**	1109	545	202	
1903	3	Nil	Nil		**1991**	1118	546	227	
1947 (Independence)	258	22	2		**1992**	1066	553	273	
1973	470	207	91		**1993**	1082	609	281	
1974	487	213	99		**1994**	1145	656	289	
1975	510	213	99		**1995**	1254	694	313	
1976	510	207	103		**1996**	1263	702	300	16
1977	510	224	108		**1997**	1318	733	302	18
1978	514	234	111		**1998**	1244	726	339	18
1979	516	245	114		**1999**	1226	748	352	24
1980	545	278	124		**2000**	1224	735	283	30
1981	655	303	132		**2001**	1377	851	370	33
1982	840	351	139		**2002**	1504	911	409	47
1983	880	379	143		**2003**	1504	908	443	71
1984	927	394	143		**2004**	1552	985	445	68
1985	1000	415	143		**2005**	Proper records could not be furnished due to lack of reliable information			
1986 (Statehood)	1017	443	154		**2006**	1700	1081	502	80
1987	1032	477	162		**2007**	1752	1090	508	82
1988	1053	498	180		**2008**	1783	1253	502	86
1989	1084	522	192		**2009**	1782	1313	521	95

Source: Statistical Wing of Directorate of School Education; Govt. of Mizoram as on 30th Sept. 2010

This development in secondary education was a healthy sign for the development of Science Education. Although there was no diversification of courses at this stage even in those times, this was the stage where Science Education was given its proper form along with all the divisions in physical and life sciences. Moreover, this is the stage where science stopped being purely theoretical and started to rely on laboratory work. In the year 2009, there was a total of 521 schools providing secondary education in different parts of the state.

1.2.3.3 Development of Higher Secondary education:

Higher Secondary Education, the stage that comes after matriculation, was not a part of the formal education ladder till the year 1996. This stage lasted for two academic years and was called the intermediate stage or pre- university stage. It was attached to colleges and they also shared the same teachers. But as far back as in 1966, the Kothari Commission had already recommended the introduction of 10+2 education in schools. After the recommendations were accepted by the Govt. of India, it was decided that all the state governments should implement this by the fifth five year plan. Although some states were able to do that, Mizoram was one of the few states who could not. During this time, education at this level was taken care of by NEHU. But in the year 1995, NEHU decided to hand over the management of pre- university education to the respective states. Consequently, the Govt. of Mizoram began to take actions in order to ensure continuity of education for the students within the state.

According to the Minutes of the Meeting held in the Office Chamber of the Hon'ble Minister on Education, on 7th July 1995**,** with regards to higher secondary education, it was decided that *colleges duly affiliated to NEHU may continue to function as usual with the change that the existing pre-university courses will henceforth come under the purview of +2 system of education*. It was also decided the Department would prepare a phased programme for the purpose.

Following this meeting, The Education and Human Resources Department, Govt. of Mizoram released an Office Memorandum on 2nd August 1995 where a list of high schools to be converted to higher secondary schools in the first three phases from 1995 to 1998 academic sessions. Out of the 26 schools which were selected, only 9 higher secondary schools were chosen to offer Science Education. But as shown by the data offered by the Statistics Cell, Directorate of School Education, as on September 2009, a total of 27 schools were offering science as a subject of study. However, districts like Lawngtlai and Mamit were still without higher secondary schools offering science as a subject. This made it clear that science education, as one went up the academic ladder, became narrow and less accessible to students.

1.2.3.4 Development of Higher Education:

Especially after the Union Territory became a full fledged state, it prioritized expansion at all levels. As such, science education saw enormous growth during the past twenty years or so. This growth was not just confined to school education but also to higher education. Table- 1.2 clearly depicts the development of Science Education at the higher education level.

Table- 1.2
Growth of Colleges offering Science Education.

Colleges	Opening	Introduction of Science
Pachhunga University College; Aizawl	1958	1973
Zirtiri Residential Science College; Aizawl	1980	2000
Lunglei Gov't. College	1963	1973
Champhai Gov't. College	1971	1997
Kolasib Gov't. College	1977	1987
Serchhip Gov't. College	1973	1998

Source: Field work.

Higher education, the last of the different levels of formal education to introduce science education has shown a late but smooth development. During the time this study was done, there were twenty seven colleges affiliated to Mizoram University. Among these colleges, six of them offered science education. Subjects offered by these colleges were mainly Physics, Chemistry, Botany, Zoology, Geology, Biochemistry, Electronics and Mathematics. But on the downside, all these subjects were not present in all the six colleges. Moreover, it was clear that in consideration of the opening of these institutions of higher education, Science Education always came at a latter stage, clearly indicating the state's priority for Arts stream. A brief history of the development of science education in the 6 colleges offering science education may be given as follows:

(a) Pachhunga University College:

The earliest and today the most well endowed institute of undergraduate education was founded in the year1958 on 15th August. Well meaning individuals of Mizoram who had completed their education outside had been raising concerted voice for the start of a college in Mizoram. The Mizos had by then clearly acknowledged the significance of college education for government jobs and eventually a life that would free them from the shackles of daily labour. So, it was with a feeling of hope and high expectations that the first institute for college education, called Aijal College was born. Although the people embraced the opening of a new college in their own hometown with open arms, lack of funds was the major hindrance that kept it from growing. But finally, the wife of one of the state's most successful businessmen decided to donate a sum of Rs 50,000.00, then a huge sum, in memory of her late husband. With this heavy donation, the college was renamed Pachhunga Memorial College. It was provincialised in 1st July 1965 and was renamed Pachhunga Memorial Government College under the Mizoram Government and continued to be so till 1972 when Mizoram became a Union Territory. The college became affiliated to NEHU in 1974 and after several proposals had been made, it became a constituent college of NEHU on 19th April 1979. This continued till Mizoram came to have its own University in 2001. Leaving NEHU the college went on to become the only constituent college of Mizoram University which is still its present status.

Initially, the college could offer only arts education. This was mainly due to lack of qualified teachers at that time. However, Science stream was opened in 1973 and the Mizos could get science education in the fields of Physics, Chemistry, Botany and Zoology. Later, in the late eighties, a new department for Geology was also opened. The college has been going through a number of changes through the years. Since it began its science stream by utilising human resources from outside the state, there was quite a good number of seats available for new comers by the time Mizoram University made its appearance and the teachers had an option to remain in the college or join NEHU. Since most of the teachers from outside joined NEHU, a number of young teachers were taken in by the college. These young minds began to work for the development of science education under the guidance of experienced Mizo teachers who by then had gathers immense knowledge in science. Being the first born, it has also accumulated the maximum resources over the years in terms of finance, land and human resources and is now one of the most sought after colleges in the state.

(b) Government Zirtiri Residential Science College (GZRSC):

The namesake of the only college in Mizoram dedicated to the study of science, Zirtiri was an English missionary whose actual name was Edith Mary Chapman. She was an enterprising lady who taught the Mizo ladies to stand up for themselves in a male dominated society. She initiated the study of Home Science in Mizoram, obstetrics, first aid and also had a special place in her heart for girls who did not have proper homes. The college was started by one of her adopted daughters, Mrs. Lalziki Sailo and her husband Mr. Lallianzuala Sailo in the year 1980. By August 1st 1980, the college was ready for regular classes. The college made good progress and by August 9th 1985, it was upgraded as a deficit college with new staff coming in, all appointed by the government.

The college was initially called Zirtiri Women's college but by the Act of the Government of Mizoram, it was called Zirtiri Residential Science College and began to devote itself entirely to science. Initially, the college had just four streams: Physics, Chemistry, Botany and Zoology. However, it has expanded in recent years. Biochemistry and computer Science were added in 2003 and since then, it has not looked back. It now boasts of a beautiful four storied building with equally dedicated staff striving to enlighten Mizoram with their scientific knowledge through their hardworking students.

(c) Lunglei Government College:

Lunglei Government College has the unique distinction of being the first college in Mizoram to materialize within five days from the date of proposal. Responding to urgent cries for a college in the southern part of Mizoram, a managing board comprising seven members was set up and they immediately made arrangement to start classes as early as possible. On 10th September 1963, the college was declared open and called Lunglei College because it was felt that it was a people's college. Against great difficulties and struggles with skeptical government officials who did not approve of another college in such an isolated area in the north east, the young college was soon affiliated to the NEHU in the year 1964.

At first, the college only offered arts education. But it slowly evolved and science stream was opened in 1973. During that time intermediate education was still under college education and it was known as pre University College or PUC. Science stream was initially just for Pre University. For this, NEHU willingly gave its affiliation on 20th October 1973. Classes continued and it was on 1st December 1976 that the college was taken over by the Government of Mizoram. A few years after this, on 2nd January 1987, the college was granted permanent affiliation by NEHU. Even after this, undergraduate courses for science still remained unavailable. It was only in the year 1992 that the government of Mizoram gave its permission for opening a science degree course. However, once it did, NEHU did not take a long time to give its provisional affiliation. By 17th February 1993, the college already had provisions for a science degree course.

The college has steadily grown over the years gaining respect due to its dedicated teachers and supporting staff who had joined without any remuneration at the start of the college. Today, it has a fully functioning science stream offering subjects like Physics, Chemistry, Botany, Zoology and Mathematics.

(d) Champhai Government College:

With a sprawling campus of 11.66 acres (34.94 bighas) of land, Champhai College can boast of having the most scenic beauty. Added to this, it also has the distinguishing feature of being one of the earliest colleges to be opened in Mizoram.

The Government Champhai College, Champhai, Mizoram was established originally as a private college in 1971 by the philanthropists of Champhai town and neighbouring villages. The founders' objective was providing collegiate education to the students of this remote hilly tribal town near the international border of India with Myanmar. It was initially affiliated to Guwahati University, then to NEHU from 1973 till 2 July 2001. Currently, it is affiliated to the new Mizoram University that came up in Aizawl, Mizoram in July 2001. In 1978 the college attained the status of deficit grants-in-aid College under Mizoram Government. The college has started degree courses in Science in 1997. The Pre-University course that was introduced in 1995 has now been delinked and the institute has only under-graduate programmes. The college received UGC recognition under 2f and 12B in 1987. It now offers degree courses for Physics, Chemistry, Botany and Zoology.

(e) Kolasib Government College:

Kolasib district has never been far behind its counterparts when it comes to education. Even when it comes to having a separate college of its own instead of its youngsters seeking admission outside their district and often coming back unsuccessful, it has not lagged far behind other districts. On 10th October 1977, the prominent citizens of the district formed a committee to start a college in the district. An office with supporting staff was opened on 28th October 1977 and thus Kolasib College was born. The first batch of pre-university college students were sent for examination in 1979. Degree education was initiated in 1981 and affiliation was obtained in1981 from NEHU. By 1985, the college was declared as a deficit college. It finally became Government college on 31st January 1992.

At first, there was only room for arts education. But seeing the need of its youth, the college opened science stream in spite of negative responses due to it being a sparsely populated district and Aizawl, the hub of education only a few hours drive away. It received affiliation for pre university education in science on 14th September 1987 and subsequently B.Sc and Science honours on 16th January 1992 and 10th June 1997 respectively.

Today, this college offers science education in the field of physics, chemistry, botany and zoology. With its motto being ‘to Enlighten’, it is working hard against various adversities to give sound education to its citizens.

(e) Serchhip Government College:

Govt. Serchhip College, an outcome of the joint venture of Serchhip and Chhiahtlang people was established on 25th August, 1973. In the past, students after getting their matriculation, had to move out for Aizawl or to outside the State to continue higher studies, a daunting task for many of the parents and families, most of whom were rural folk who were financially and educationally underprivileged.

In 1975, it was given affiliation by North Eastern Hill University (NEHU) and subsequently to Mizoram University when the University was established on 2001. The state government gave financial assistance to the College under ‘Govt. Aided Scheme’ and was upgraded to the Deficit Grant-in-aid Status with effect from 1st November, 1984 until it was provincialised by the Govt. of Mizoram on 1st January, 1989. The College has also been placed under section 2(f) and 12(B) of the UGC Act, 1956 vide letter No.F.No.8-93/86 (CPP-1) dt. 27. 10. 1990. Starting with Arts Faculty comprising of five Departments only in 1973, the number of department had now increased to fourteen with Science stream introduced in 1998. But, due to the amalgamation policy of the government, science stream was pulled back in 2000. Fortunately, the science stream at present, the college has 14 departments, which are constituents of two faculties – Arts and Science. There are 156 under-graduate students (73 boys and 94 girls) in the academic session 2009 – 2010 pursuing their education under 56 teaching staff (31 permanent and 25 guest lecturers).

The science stream offers degree courses in Physics, Chemistry, Botany and Zoology. In spite of the fact that does not have the infrastructural wealth that most colleges possess, it continues to produce science graduates who have went on to become worthwhile citizens of the state.

1.3 Important Landmarks in the History of Science Education in Mizoram:

1.3.1 Directorate of School Education:

The Directorate of School Education was set up soon after Mizoram became a Union Territory in the year 1972. By 1st July 1972, it was already functioning as an independent directorate. The government placed one director, one joint director and two deputy directors and several state level officers to implement various educational schemes. The Science Promotion Officer was one of the state level officers appointed to promote science education throughout the Union Territory. The Directorate of School Education still takes care of The Science Promotion Wing even to this day. Earlier on, the Directorate took care of school education from primary to secondary education. But since 1996, North Eastern Hill University handed over the intermediate education also called pre university education which it had attached to colleges. From this moment on, the responsibility of the Directorate increased and the intermediate education was renamed higher secondary education and was attached to secondary schools as senior high schools.

1.3.2 Science Promotion Wing:

The Science Promotion Wing started delivering classroom teaching with the assistance given by UNICEF in July 1973. The Science Promotion Officer was assisted by two science consultants. Training courses for primary and middle school teachers were initiated soon afterward. Text books were distributed and science exhibitions were organized so as to garner maximum publicity for science education. Even after the UNICEF project was terminated, this wing continued to be the key player in the field of science education especially at the school stage.

1.3.3 Mizoram Board of School education:

Another big development for school education was the setting up of the Mizoram Board of School Education or MBSE as it is more conveniently referred to. The Board was set up by the Mizoram Board of School Education Act 1975 on 14th December 1977. It is an autonomous body with the responsibility to prescribe text books and syllabi from primary to higher secondary school education. It is also the affiliating body for schools and as such it lays down certain guidelines for schools to be recognized by the government. In fact, some of the prerequisites that it has made for school science education have been used as a checklist by the investigator to find out the status of laboratories.

1.3.4 State Council of Educational Research and Training:

Another landmark in the development of science education was the establishment of the State Council of Educational Research and Training, Mizoram in the year 1980. This is the apex organization set up by the government to assist and advise it in academic matters that relate to school education. The Science Promotion Wing, which had been functioning as a separate wing under the Directorate of School Education became a part of this body. Till the time that this research was undertaken, The Science Promotion Wing continues to function as another wing promoting science education at the school level. It was initially strongly focused toward primary education but as science education developed, its interest has now expanded to middle, secondary and higher secondary school education.

1.4 Relevance of the Study:

According to the India Science Report (2005), with more students enrolling for science education (28% of all enrolments at the graduate-plus level were in the science field in 1995-96 and this went up to 31% in 2004) things seem to be hunky dory for science education in the country. *However the cause for worry lies in the fact that students seem less inclined in pursuing pure science when it comes to a higher degree, whether graduation or post-graduation. At the class six to eight levels, 22 % say they would like to study pure science. Yet, this percentage drops to 13.4 % among students in class 11 and 12 who want to pursue pure science at a higher level*[8].

The present topic has been selected because of a number of reasons, some of which have been highlighted as follows:

---

[7]**India Science Report**, Science Education, Human Resources and Public Attitude towards Science and Technology,2005.

(i) India follows a uniform pattern of education wherein students learn all subjects till they complete high school. From the higher secondary stage, students can have their choice of disciplines though there are still subjects that are considered compulsory. At the college levels, there is complete diversification and students are firmly in their chosen fields. Therefore it is important to have a proper knowledge of the percentage of students who have chosen science.

(ii) Mizoram is one of the smallest and youngest states in India. Yet it has been steadily growing and its educational system has also matured to a certain extent especially after its statehood in 1986. Today, it stands second in literacy rate next to the state of Kerala. But if the state is to be an active participant in national development, its science education needs to be looked into because without the knowledge of science, no technological development can take place. And if science education is weak in the state, it can never hope to compete with other states in technological development.

(iii) When science is taught out of context, it becomes boring and also difficult to understand. Science education has to speak to the mind and the hand as well. It is important to have a curriculum that has practical value, teachers that are qualified and trained as well as equipment that will meet the needs of practical study. Therefore, the time is now ripe for an in depth research into these matters in order to find out the real situation.

(iv) Lastly but nevertheless important, lack of reliable data in the field of science education is one big hindrance to policy making. The state needs proper investigation of its status in science education to facilitate the work of policy makers and also to identify weak spots.

Over and above these points there are certain questions that have been agitating the minds of parents, teachers and the community at large. Some of these questions are:-

i) When was Science Education initiated in Mizoram and how has it developed?

ii) Do we have adequate, qualified and trained teachers?

iii) Are our Science laboratories properly equipped?

iv) Are practical works conducted as projected in the school/college time tables? How much time is devoted for practical activities?

v) Has there been any improvement in the performance of students in science?

vi) Does the State have the required kind of organizational structure for the improvement of science education? Are these organizations playing their expected role?

vii) Does the state possess specific policies and programmes for Science Education?

Therefore, it becomes the sacred responsibility of researchers to address these questions through research. Hence the need of taking up research on this topic.

1.5 Statement of the Problem:

In view of the research questions which needed immediate answers, the present study has been stated as:

"STATUS OF SCIENCE EDUCATION IN MIZORAM: A CRITICAL STUDY "

1.6 Objectives:

The following objectives were identified in order to acquire the right information and give light to the true status of science education in the state from a critical point of view:

(i) To study the development of Science Education in Mizoram.

(ii) To determine the adequacy or otherwise of practical activities organized for teaching of science education at different levels of education.

(iii) To examine the status of science laboratories in high schools, higher secondary and collegiate level in the last five years (i.e. 2002-2007).

(iv) To prepare the profile of science teachers at high and higher secondary schools and collegiate level.

(v) To examine the policies and programmes of the state government for the promotion of science education.

(vi) To analyse the examination results of the last five years (i.e. 2002-2007) in science subjects at high, higher secondary and collegiate level.

(vii) To examine the role of science promotion wing of SCERT, Aizawl in the development of science education in Mizoram.

(viii) To suggest measures for the improvement of science education in Mizoram.

1.7 Delimitation:

The present study has been confined to high school and undergraduate science education because at the time the study was initiated (2007), there was not enough proper post graduate programmes for science education under Mizoram University to throw light on the percentage of science students who were able to continue their post graduate education based on their choice in the under graduate programme. Middle School was left out because at this stage, science education is at the fundamental stage and other than the absence of practical work, there is no clear division of the science courses as found in the secondary stage.

1.8 Structural Framework of the Study:

The present investigation has been designed as follows so as to suit the various objectives and enable the scholar to present them in a precise manner:

Chapter – I: The First Chapter deals with the introduction, theoretical framework, rationale of the study, objectives and delimitations as well as structural framework of study.

Chapter – II: The Second Chapter titled 'Review of related literature' encompasses the related studies conducted in India and abroad and place the study in the context of the related literature.

Chapter – III: The Third Chapter on the Methodology includes matters relating to the method of study, tools of data collection, sources of data and statistical treatment of data.

Chapter – IV: The Fourth Chapter is on Analysis and Interpretation of Data relating to various issues regarding Science Promotion Wing in Mizoram.

Chapter – V: The Fifth Chapter is on Analysis and Interpretation of Data relating to the ‘Status of Laboratories, Practical Activities and Time Tables’ of sample institutions.

Chapter – VI: This Chapter is focused on the ‘Profile of Science Teachers’ from HSLC to College level.

Chapter – VII: Chapter Seven concentrates on ‘Development of Human Resources in Science Education’ with emphasis on enrolment and examination results at various levels of education.

Chapter – VIII: Chapter Eight, the final chapter includes the major findings, recommendations and suggestions for further research for the improvement of Science Education in Mizoram.

CHAPTER-II

REVIEW OF RELATED LITERATURE

2.0 Introduction:

Research in Science Education is an area where interaction between behavioral sciences and natural sciences take place. Different aspects of Science education have often been the subject of research in different countries. Science education at school, college and university levels has been the subject of study by a number of Researchers each with their own unique findings. Research in science education has mostly been confined to attitude studies, curriculum, teaching strategies, scientific literacy, determining the actual state of knowledge in science education and educational technology used in the teaching of science. The findings of these researches have definitely influenced Science Education in many positive ways. They have also served to provide answers to unresolved problems in the teaching of science. This chapter has been organised and presented under the following sub- heads:

2.1 Studies done in India
2.2 Studies done Abroad
2.3 Studies of Research in Science Education in India: A Macro Analysis
2.4 Relevance of the Present Study in the Background of Studies Reviewed.

2.1 Studies done in India:

For the present investigation, the scholar has chosen to make a review of only the most recent research works. The study done by Veerapa in 1958 has been included because of its distinction as the pioneering work done in this field. From then on, numerous studies have been done on science education some of which may no longer be pertinent due to passing of time and some of which may not be useful to the present study. However, few studies relevant to the present study have beens reported as under:

Veerapa (1958) conducted a study to examine the position of science education in India and assessed the developing trends on the basis of the observations done in USA, UK etc. The feasibility of introducing these trends in Indian institutions was also investigated. He found that teaching of science through Herbertian Plans, the Lecture Method and Essay type questions in the examinations were quite popular.

Molley (1988) in his study on 'Facilitations amid hindrances to the modernisation of chemistry teaching in the schools of Kerala' found that:

(1) There was a gap of a decade between the introduction of modern concepts in chemistry and the corresponding modem pedagogical approaches.

(2) The overall attitude to the modernisation of science was favourable.

(3) The correlation between age and attitude was positive for teachers and negative in the case of experts.

(4) Workshops and in-service education programmes organised by the department of education received the topmost rating within the context of modernisation of chemistry teaching.

(5) Several facilitating and hindering factors were identified which related mainly to the administrative aspects.

Radhamonyamma (1988) did a study on 'Evolving instructional techniques appropriate to the development of various scientific skills among secondary school pupils in Kerala.' The study found that:

(1) Whereas the achievement in science as well as acquisition of scientific skill was low, it was observed that the newly evolved method for teaching of scientific skills through tested lesson plans was more effective than the traditional method.

(2) The correlations between marks scored in different science subjects were higher for the experimental group as compared to the control group.

Singh (1988) did a study on ‘Attitudes of secondary stage students towards science curriculum and its relationship with achievement motivation’ and found that:

(1) Students from rural and urban schools as well as male and female had favourable attitude towards science curriculum.

(2) There were significant differences in some aspects such as scientific temper, and teaching methods.

(3) Students from urban schools scored highest on the achievement test.

(4) Most of the weak students scored less on the achievement test.

(5) Female students scored higher than their male counterparts.

(6) Enriched academic programmes helped in developing favourable attitudes.

Mohanty (1988) made a study on ‘An appraisal of teaching science in the high schools of Cuttack City’. The study revealed that:

(1) After administering tests in two subsequent years, the performance of the students in the second test was slightly inferior to the first test.

(2) Though various factors like pupil ability, the teacher's teaching methods, laboratory facilities -.-ere almost the same from year to year.

(3) According to the expert, the present syllabus was very tough and it was very difficult to grasp all the concepts in 10 years of schooling. They also opined that the Board of Secondary Education, Orissa should appoint more experts in science to improve science teaching in the state and also to revise the science syllabus keeping in view the teachers' position, laboratory facilities and the standard of the students.

(4) As regards the equipment and laboratory, all the schools were deficient. All the teachers followed the demonstration-cum-discussion method for teaching science which was suitable for their condition.

(5) The schools were deficient in audiovisual aids like projectors, overhead projectors, television sets, etc.

(6) The outcomes of learning were not properly assessed by the schools. The questionnaire revealed that the outcomes of cognitive domain were assessed to some extent and the outcomes of affective domain were not assessed at all.

(7) The science funds available to the schools were very meagre. So the schools could not do a lot for the development of science education by organising science fairs and science exhibitions in the schools.

Shardamba. (1988), in his study on ‘Explorations in optimising learning science in schools’ observed that:

(1) The learning process scores and concept scores were low indicating to the science educator that comprehension was not achieved by giving children bits of information about scientific facts.

(2) Science achievement test indicated that very little was retained by children by rote memory.

(3)The positive relationship in general between science achievement test scores of children and the educational level of parents provided reasons to believe that strengthening of educational level and also science background of the parents was likely to enhance the science achievement of the children.

(4) On science achievement items related to Grades III, IV and V for earth science, physical science and biological science, it was found that irrespective of the region, the scores on earth science in items related to Grade V were invariably higher than the scores in items related to Grade HI, whereas in physical science the reverse was true. In biological science, there was more or less uniform distribution of scores over Grades III, IV and V.

Shrivastava (1988) made 'An investigation into the scientific aptitude of higher secondary science students in relation to their cognitive style.' She observed that:

(1) The male students were better than female students in the area of scientific aptitude as significant difference was found between both the groups.

(2) Both the groups of boys and girls were of high scientific aptitude and had insignificant difference on dogmatism.

(3) The male and female students of low scientific aptitude had significant difference on dogmatism.

Sivadasan (1988) did a study on 'Linking class teaching with science club programme in Kerala.' It was found that:

(1) The teaching-learning strategies now adopted in schools are not oriented to the development of scientific process.

(2) Members and non-members of science clubs were found having low and non-significant difference under the majority of categories of scientific attitude.

(3) The science club members were found significantly better than the non-members in composite performance skill.

Saxena (1988) made a study of 'Sequential attainment of concept in chemistry through periodic table at the secondary stage.' He observed that the experimental group taught by discussion method and supplemented by reading material regarding the related concepts gave better results in terms of their performance.

Sundararajan (1988), in his study on ‘Evaluation of the teaching of biology at higher secondary stage in Tamil Nadu’ found that:

(1) Hierarchy of the objective related to the teacher gave more importance to the knowledge, followed by understanding, application and skills.

(2) Generally teachers were found to follow only the expository type of teaching strategies in their teaching of biology. They did not encourage discussion among the students and other student-centred teaching techniques.

(3) The higher secondary biology syllabus was related only to the students' abilities and to their real life. It was not conducive to the students learning the scientific method, the development of scientific interests and a favourable attitude towards the study of biology in them and their appreciating the contribution of biology to human civilisation. Moreover, it was overloaded with facts, traditional and product-oriented.

(4) The biology textbook too was found to be defective in many respects. It did not include a glossary of technical terms, an index, list of assignments, list of practical activities and list of local fauna and flora. There were many printing mistakes. The technical terms were not fully described and some of the diagrams were not fully labelled.

(5) The biology laboratories were in a bad shape. A full complement of chemicals and equipment was not found in many schools and they did not have essential teaching aids, too.

(6) Objective type questions were not asked in the final higher secondary examinations conducted by the Government of Tamil Nadu and there were no questions testing the 'Application' objective in biology. Even questions testing

the 'Skills' objective were few. All the questions seemed to encourage rote memory of the students. The practical examinations only tested the knowledge of skills and not the skills themselves.

(7) The urban boys did not show greater achievement in biology than the rural boys and the urban girls respectively. But the urban girls showed greater achievement in biology than the rural girls and the rural boys too showed greater achievement in biology than the rural girls, in respect of the four objectives of teaching biology, viz. knowledge, understanding, application and skills. The performance of +2 biology students was the best in respect of the items testing skills and the poorest in respect of the items testing understanding.

(8) The majority of +2 biology students had a favourable attitude towards the study of biology. Boys in urban schools did not have a more favourable attitude towards the study of biology than the girls of urban schools and the boys of rural schools. But the boys in rural schools and the girls in urban schools had a more favourable attitude towards the study of biology than the girls of rural schools.

(9) There existed a positive relationship between the higher secondary students' attitude towards the study of biology and their achievement in it.

Mohapatra (1989) studied ‘Four dimensions of the teaching-learning of science: Characteristics and implications’ It was observed that:

(1) Children made a great deal of conceptualisation on the basis of their observation of day-to-day happenings in the environment and in home situations. In this process they formulated alternative concepts about things, objects and events.

(2) The science teacher had an important role in helping the child to develop proper concepts about objects and events by utilising children's personal experiences with the rational thinking process.

Darchhingpui (1989) did ‘A study of science achievement, science attitude and problem-solving ability among secondary school students in Aizawl’ and the study indicated that:

(1) there was significant relationships between scores on scientific attitude and achievement in science.

(2) Significant sex differences in achievement in science and problem-solving ability existed.

(3) High socio-economic status, family facility and type of school attended favoured achievement in sciences, scientific attitudes and problem-solving ability.

Ghosh (1989) in his ‘Critical study of scientific attitude and aptitude of the students and determination of some determinants of scientific attitude’ concluded that:

(1) Scientific aptitude was significantly related to scientific attitude and academic motivation.

(2) No significant difference was observed with respect : sex, socio-economic conditions or place of habitation.

Pandit (1989) made ‘An Identification and measurement of chemistry laboratory skills of senior secondary school students of Delhi.’ The study revealed that:

(1) From the cognitive and psychomotor domains of learning, a comprehensive list of chemistry laboratory skills was prepared which were needed for Class XII students. Out of the two categories in the comprehensive list, 46 were found relevant to the study.

(2) It was possible to construct tests for measuring various chemistry laboratory skills with a high degree of reliability and validity.

(3) It was possible to classify several chemistry laboratory skills into major skills.

(4) A significant correlation was found between the ability to learn the subject-matter content and the ability to learn cognitive as well as manipulative laboratory skills.

(5) There existed a significant school variation in the achievement of chemistry laboratory skills.

(6) It was observed that factors such as type of schools, sex, etc. had significant effect on the acquisition of laboratory skills.

Prakash (1990) investigated the 'Effectiveness of concrete materials to enhance learning in physical sciences' and found that:

(1) The performance of student's learning by concretised instruction was better, than those learning by traditional instruction.

(2) The average increments in marks of the experimental group of students on concrete level items was 8.8% and that of formal level items, 8.4%. As the tests comprised of items based on different logical operations and of concrete and formal operational level, the responses of such tests may be used to diagnose the learning difficulties of students. Remedial help can also be provided to them accordingly.

(3) The use of concrete materials such as charts, models, analogies, more lucid examples and other materials (that could be manipulated) based on concrete

thoughts and sequencing of instruction in a three-stage cycle were found to help the concrete level operators in understanding the formal level concepts more effectively. The three-stages of learning cycles were introduction, concept formation and concept application.

Goel et.al (1990) in a study 'Learning physics through lecture-demonstration method (LDM) and individualised instruction method' found that:

(1) A significant difference was observed between the groups which followed the individual laboratory method and the lecture demonstration method.

(2) The group of students following the individual laboratory method achieved significantly better on the psychomotor skills than did the lecture-demonstration group.

(3) Students who followed the lecture demonstration method achieved at a higher level related cognitive skills than did the group of students which followed the individual laboratory method.

Gurumurthy (1990) made 'A comparative study of the effectiveness of guided discovery approach of doing physics experiments versus Instructed Performance Approach at pre-university level.' His study revealed that:

(1) Significant differences were observed between the students of the Guided Discovery Group (GDG) and Instructed Performance Group (IPG) in the mean scores of (a) comprehensive achievement and its components such as knowledge, understanding and application, and (b) practical skill abilities.

(2) No significant differences were present between the GDG and the IPG of the mean scores of comprehensive creativity and its components such as frequency, flexibility and originality.

(3) No significant differences were present between pre-creativity and post-creativity test scores in GDG or in IPG.

(4) Significant difference between mean scores were observed between the GDG and IPG with respect to their performance in post-achievement test and skill test between the different sub-groups—intelligence levels, SES levels and sex.

(5) When the students were classified according to their sub-groups— intelligence, SES and sex—the performance of GDG students was found to be better than that of IPG students on post-achievement and skill test.

(6) The effect of GD approach was found to be equally good for high and low intelligent boys and girls, in the performance of past achievement test.

(7) No significant mean difference was observed between the GDG and IPG with respect to their performance in post-creativity test (between the different sub-groups.

Kar (1990) made 'A study of relationship between attitude towards and achievement in general science of Class IX students of Cuttack city.' It was found that:

(1) The distribution of the attitude score was negatively skewed.

(2) Boys were found to be more favourably disposed towards science than girls.

(3) There was positive relationship between attitude and achievement.

Malik (1990) conducted 'A study of the impact of investigatory approach upon student-teachers' cognitive appraisal and its implications for Science Teachers' Training Programme' He found that:

(1) The reactions of science teachers about the Investigatory Approach strategies were favourable.

(2) There was an identical cognitive orientation after learning through the modular structured reading material stage.

(3) Learning of Investigatory Approach through viewing live demonstrations resulted in the improvement of the cognitive appraisal about the approach.

(4) Learning of Investigatory Approach through peer-teaching showed significant improvement in the cognitive appraisal.

(5) The cognitive appraisal in each stage of learning differed in a substantial manner, reflecting the distinct stages of learning as differentiable from the continuum of thoughtless to the thoughtful modes of functioning.

(6) The maximum gain in cognitive appraisal was at the stage of learning the approach through viewing live demonstrations.

(7) Implementation improved the cognitive appraisal but the change in cognitive appraisal was not statistically significant.

(8) The student-teachers who learnt Investigatory Approach through structured reading material had much lower gain by this treatment than those who learnt the approach through modular structured reading material, viewing live demonstrations and peer-teaching.

(9) The effectiveness of the implementation strategy was dependent upon the initial learning experience.

(10) Satisfactory learning through the training programme determined the workability of Investigatory Approach at the implementation stage.

(11) Classroom performance was dependent upon learning and experience that could actually be implemented.

(12) Theoretical acquisition of knowledge of Investigatory Approach did not result in propositional (functional) knowledge of Investigatory Approach.

(13) Student-teachers' thinking while learning the Investigatory Approach as inferred from their responses after Stages I, II and III of treatment were in terms of doubts and fears about different dimensions of Investigatory Approach strategies.

(14) Student-teachers' thinking after learning through implementation experiences were in terms of suggestions for the effective implementation of Investigatory Approach strategies.

Alexander(1990) in his study on the 'Relationship of critical thinking, science aptitude and socio-economic status to the science achievement of second year PUC. Students' found that:

(1) Sex differences in achievement in science favouring males existed.

(2) No significant interaction effect between each of the independent predictors taken separately favoured achievement in science.

Ghose (1990) made 'An Investigation on non-formal science education and development of inexpensive resource materials' and the study revealed that:

(1) Several participants were actually utilising their knowledge in the preparation of daily food of the family even several months after the termination of the programme.

(2) It was found that the growth rate increased for leafy vegetables, varying from marginal to 30% depending on the type of plants and the extract used. It also established the general methodology of basic agricultural studies.

(3) It was found that traditional methods which emphasized familiarity gained through practices was in no way inferior to the methods proposed in the project. On the other hand, persuasion of scientific methods of structural industries at a still higher level would be only rarely needed in actual practice and this did not encourage enthusiastic participation in the programme.

(4) A positive correlation was established between the onset of pulmonary diseases and the presence' of nitrous fumes among workers in jewellery manufacturing shops. However, the remedies suggested were not acceptable

because they hampered production.

Sharma (1990) performed 'A study of scientific literacy, attitudes towards science and personality traits of students and teachers' and he revealed that:

(1) The total sample had higher level of scientific literacy than the theoretical mean.

(2) There was significant difference between the general group and the SC/ST group.

(3) The total sample had favourable attitude towards science.

(4) There was effect of type of school and sex on attitude towards science.

(5) There was no significant difference between students and teachers on personality factors.

Shishta (1990) made an investigation into 'The effectiveness of guided discovery learning vis-a-vis the conventional approach to the teaching of scientific concepts in life sciences.' It was observed that:

(1) The performance of the experimental group was superior to that of the control group on the concept achievement test in photosynthesis.

(2) It appeared that the treatment of teaching concepts of photosynthesis with blended strategies and different modes of teaching had brought significant difference in the achievement of biological concepts.

Rao (1990) made 'A comparative study of scientific attitude, scientific aptitude and achievement in biology at secondary school level.' It was observed that:

(1) The scientific attitude in secondary school pupils was average. There was no influence of sex on scientific attitude. But the pupils studying in private schools, rural schools, English medium schools, and residential schools held relatively better scientific attitudes than their counterparts.

(2) The scientific aptitude in secondary school pupils was also average. The pupils of private schools, urban schools, English medium schools and residential schools held a bit more scientific aptitude.

(3) The achievement in biology was average. The rural schools, government schools, English medium schools and residential schools were better in achievement.

(4) There was a highly significant and positive association among scientific attitude, scientific aptitude and biology achievement.

Gupta et.al (1990) made 'A Study of science laboratories in secondary schools in selected states.' His study showed that:

(1) In Maharashtra, out of 111 secondary schools, 105 were reported to have science laboratories. Almost all schools — 96.7% in urban areas and 92% in rural areas — had science laboratories.

(2) Out of 70 higher secondary schools which responded, 59 had science laboratories. In urban areas, 94.7% were having science laboratories as against 71.9% in the rural areas.

(3) Out of the 105 secondary schools which had science laboratories, only 26 had separate laboratories, i.e. hardly 25%. In the urban area, the position was better than rural areas.

(4) Out of 58 secondary schools in rural areas, about 60% used one to three hours per week for teacher demonstrations, 20% used four to five hours time and remaining 40% used seven hours and more for teacher demonstrations. In urban schools, the position was slightly better. About 40% schools used

laboratories for one to three hours, another 20% used it for four to six hours and the remaining used it for seven hours and above.

(5) Time devoted to science practicals differed in urban and rural schools. The position in urban schools was worse than that in rural areas.

(6) In higher secondary classes, 38 out of 59 schools in Class IX, i.e. 60% and 40 out of 59 in Class X, i.e. 70% performed teacher demonstrations. The position in respect of students' practicals was highly satisfactory in Class XI and 89% in Class XII performed more than 15 student practicals.

(7) In Rajasthan's secondary school 92.10%) rural schools had laboratories as compared to 83.3% urban schools. In the case of higher secondary schools, 94.60% rural schools had these facilities as compared to 90.90% in urban schools.

(8) The facility of separate laboratories was available in 91.9% urban schools as compared to 85.7% rural schools.

(9) About 50% of school students had the facility of performing experiments individually in physics, 74.74% in chemistry and 81.72% in biology.

(10) For performing science practicals, in case of private aided and private unaided schools, only 80% and 66.7% schools respectively allotted adequate time for performing science practicals.

(11) Only 27.8% of government schools had the facility for repairing and improving of science equipment. In rural areas this facility was available in 14.8% secondary schools and in urban areas, 66.7% secondary schools.

(12) 7.5% of government school charged 6 to 10 rupees as science fee and 75.3% in case of higher secondary schools.

Anwar (1991) did 'A study of the effect of short-term content enrichment programme to overcome the deficiencies of trainees in science subjects in TCH course.' His major findings were:

(1) There was no significant difference among the experimental and control groups in the content competence in general science before the enrichment programme.

(2) There was a significant difference between the experimental and control groups in the content competencies in general science after the enrichment programme.

(3) There was no significant difference between the variables—sex, institution, location and SES of student-teachers in the learning of science subjects.

(4) There was no significant difference between experimental and control groups in the learning of science subjects in practice teaching before the enrichment programme.

(5) There was a significant difference between the experimental and control groups in the learning of science subjects and in practice teaching after the enrichment programme.

Deshmukh (1991) conducted a study on 'Science education as a means of social change with special respect to health and hygienic habits' and he found that:

(1) Using pre-test post-test control group experimental design, the programme so developed was found to be effective as judged by gains in scores favouring the experimental groups.

(2) However, it was noticed that there were some serious difficulties such as loaded curriculum, lack of physical amenities and time, ignorance of parents and failure to practice by the students in their homes what they had otherwise understood in the classroom.

Ekpo (1991) did a study on 'Chemistry laboratory safety skills and practices: Students' self-evaluation in selected secondary schools in Akwa, Ibom State' He came to the following conclusions:

(1) More than 70% students failed to protect their eyes, face, hands and even their body too.

(2) They did not wear aprons and gloves while engaged in chemical experimentation.

(3) They had poor knowledge about identified emergency facilities and equipment.

(4) It also, revealed evidence of poor experimental techniques.

Vaidya (1991) in his study on 'Developing teaching-learning strategies for enhancing student achievement in science' found that:

(1) It was possible to discern fluctuations of thought remaining under the permissible limit of 10%.
(2) It was possible to accelerate thought under certain conditions such as arranging thought-provoking problems in their hierarchical order but abstract Piagetian schemes of thought were difficult to crack.
(3) It was very much possible for children to help themselves in their day-to-day teaching-learning provided, the teacher did not always insist on the right answer. The wrong answers, in fact, revealed the evolving structures of their logical thought.

MaMya (1991) made a study of 'Attitude towards science and interest in science of school-going adolescents'. His study revealed that:

(1) A positive attitude towards science was observed among all the six groups of students (boys-girls, tribal school-government school, private school-educational school, rural school-urban school, general castes-backward castes students, and high socio-economic status-low socio-economic status of students).

(2) Significant difference between means of rural school and urban school boys and girls revealed that attitude towards science differed in respect of sex in early ages.

(3) No significant difference between male and female teachers' attitude towards science revealed that sex had no effect on the attitude towards science in the later years.

(4) Significant difference between means of rural school and urban school boys and girls revealed that attitude towards science differed in respect of area.

(5) No significant difference between male and female teachers' attitude towards science revealed that sex had no effect on the attitude towards science.

(6) No significant difference between experienced and new teachers revealed that an increase in age had no effect on attitude towards science.

(7) Significant difference between the mean scores of boys and girls on different factors of attitude towards science and significant in mean scores of students and teachers on different factors of attitude towards science revealed that age, sex, profession and socio-economic status had no effect on attitude towards science.

(8) Coefficient of correlation between the different factors of attitude towards science showed moderate correlation with each other.

(9) Coefficient of correlation between the different factors of interest showed moderate correlation with each other. The correlation of scientific factor was comparatively higher than other factors.

(10) The mean score and standard deviation of the scientific interest factor was higher than other interest factors. This showed that the students who had got higher positive attitude towards science would also have higher scientific interest.

(11) Attitude and different factors of interest, i.e. mechanical, business, scientific, aesthetic were significantly correlated. Attitude and clerical factor of interest was also significantly correlated. Other two factors of interest, namely social and outdoor factors did not show significant relationship with attitude.

(12) Obtained value of 'F' on the basis of one-way analysis of variance showed significant difference between the different groups of students in the attitude towards science.

(13) The value of 'r' in case of scientific factor was higher than other factors. It clearly showed that the students who had positive attitude towards science also had greater interest in science.

(14) A 't' test analysis of attitude scale showed significant positive gains in attitude towards science for the entire groups of students.

Dubey (1992) in his work on ‘A study of the scientific temper and its measurement’ found that:

(1) All the groups of students and teachers manifested scientific temper.

(2) Significant differences in scientific temper were noticed between male science teachers and male non-science teachers; female teachers and male teachers, rural girls and urban girls, urban boys and urban girls and finally, male science students and female science students.

(3) No significant differences appeared between female science and non-science teachers as well as science students and non-science students.

(4) The mathematical structure of tools and tasks as used in this study showed the existence of two factors, namely, curiosity and aversion, to superstitions.

Nelliappan (1992) made a 'Study of scientific attitude and interests among higher secondary biology students in relation to their learning environment.' He found that:

(1) There was a strong relationship between the high and low total learning environment of the higher secondary biology students and their scientific attitude and scientific interests.

(2) The total learning environment and the scientific attitude and scientific interests of the higher secondary biology students were significantly related in respect of the entire sample and of the various categories of sub-samples.

(3) The high and low total learning environment groups of the higher secondary biology students significantly differed in their scientific attitude and scientific interest and this was true in respect of the entire sample, urban students, rural students, boys and girls. Significant difference was observed only between the high and low learning environment group combinations among the various combinations of sub-samples involving sex, locality and levels of learning environment in respect of the scientific attitude and scientific interests.

Srivastava (1992) in his 'Study of creativity among higher secondary students in relation to scientific aptitude and attitude towards science' discovered that:

(1) The science students of higher secondary classes having more scientific aptitude were more creative than those having less scientific aptitude.

(2) In the field of creativity, the boys having favourable attitude towards science were slightly better than those having unfavourable attitude towards science

whereas the girls with favourable and unfavourable attitude towards science did not differ.

(3) The girls were more creative than boys.

(4) The boys had more scientific aptitude than the girls.

(5) The girls had more favourable attitude towards science than the boys.

Garg et.al (2003), in their 'Study on +2 and undergraduate level science education' found that:

(1) The priority for life sciences has gone down considerably in comparison to that for physics and Chemistry in respect of CBSE.

(2) A comparison of the results of the +2 stage and that of B.Sc. showed that there were a number of students who drifted out of general B.Sc. courses to study professional courses, some of them fail and some of them also completely drop out. The researchers called the students who have chosen other professional lines as 'drift- outs' in order to distinguish them from the actual drop outs.

(3) The study revealed that the drift out rate was much higher for B.Sc. general stream (pass course and honours course) than B.Sc. for applied sciences.

Shukla et.al., (2005) in their work on 'Science Education, Human Resources and Public Attitude towards Science and Technology' in India, found that, among other things:

(1) India scores lower than the US on attitudes towards science and technology, but not much lower. Seventy seven per cent Indians feel S&T makes our lives healthier and easier as compared to 86% for the US. Sixty one per cent feel technology makes work interesting as compared to 89% in the US.

(2) In overall terms, Indians believe that the positive attributes of S&T outweigh the negative attributes by 1.1 times, a figure that is not too much lower than the US' 1.3.

(3) India has 48.7 million people who have at least a graduate degree and about a fourth of these have a background of science education.

2.2 Studies done Abroad:

Studies connected to science education have been done in various countries but always with a slant on the attitudes, abilities and with stress on new topics to be included in science education rather than on the status of science education. However, a few of the researches which may have relevance to the present study have been summarized as follows:

Charen (1963) conducted 'A study to see the effect of open ended experiments in chemistry' of the achievement of the following objectives for science teaching:

(i) gain in facts and principles in the laboratory;
(ii) develop ability to do critical thinking;
(iii) teachers, appraisal to the technique; and
(iv) development of positive attitude.

The findings revealed that the majority of students (63 percent of respondents) showed a positive attitude towards the open-ended experiments and felt that they were not too difficult but challenging, stimulating and thought-provoking.

Milson(1972) conducted 'A study on ninth and tenth grade below average students' to evaluate the effects of Physical Science, curriculum material in terms of attitude towards science instruction, attitude towards school, attitude towards science teacher and the topic of the material. Some of the major conclusions of the study were:

(1) the presentation of the Physical Science Curriculum materials did significantly improve the attitude towards science class and science laboratory of the below average students,
(2) the attitude towards teacher was not changed as a result of presentation of the curriculum materials; and
(3) positive changes in attitude towards school and the topic were found due to the exposure of PSC material.

On a study undertaken by **Gardner** (1975), it was found that students who opt for science courses were mostly serious, achievement oriented, realistic, independent and conventional. Science educators found it difficult to attract other personality types to science. He also found that interest in doing laboratory work is likely to be positively correlated with attitudes towards biology or towards other science careers.

Wright (1977) found that the conventional curriculum was more effective in developing positive attitude towards science than the Science curriculum Improvement Study while both the curricula were equally effective in development of process Skill. These findings were reported when Wright conducted a study on 63 matched pair students of the seventh grade.

Burow (1978) attempted to find out the relationship among the student's locus of control, view of the tentativeness in science, attitude towards science instruction, perception of teaching strategies and achievement in science. The study was carried out in a public school covering the students of grade IX to XII. The study revealed the following two major conclusions:

(1)students who had more positive attitude towards science instruction tended to be more internal in nature, to view science as more tentative, to perceive science class as being more inquiry-oriented and to achieve more in science class; and

(2) Students who achieved more in a science class tended to be more internal in nature, to view science as more tentative in nature, to have a more positive overall attitude towards science instruction and tended to perceive the science class as more inquiry-oriented.

Robinson (1980) conducted a 'Comparative study to evaluate the relative effectiveness of an interdisciplinary science curriculum namely 'Human Science Programme' as compared to the Conventional programme.' The effectiveness was measured through a questionnaire which constituted the four scales namely evaluation (like vs. dislike), value (worth), activity (active involvement) and interest. Four hundred & two grade VIII students participated in the study. The findings of the study were encouraging. The students who followed the Human Science Programme showed a greater positive attitude towards the course and found the course of more value when compared to with those who experienced conventional programme. The Human Science students also felt their course as full of fun, important and pleasant. The study also revealed that the girls rated conventional course lower than their boy counter parts.

Kyle et.al. (1988) made 'A comparative evaluation of Science Curriculum Study with Traditional Curriculum in terms of attitude towards science of students as well as of their teachers.' The findings revealed that inquiry-oriented science curriculum was more effective in development of favourable attitude towards science among students as compared to the conventional curriculum but it failed to show any significant difference in case of teachers' attitudes towards science.

Seymour et.al (1997) found that a loss of over half of the students who enter college intending to pursue majors in the natural sciences occurs within two years of taking their first college science class, a problem of wastage that affects both minority and majority students. Students reported being dissatisfied with what they perceived as poor teaching and other negative experiences in "weed-out" science courses.

Bandura (1997) discovered through his research that self-efficacy beliefs are often translated into action. He also found that efficacious science teachers are more open to new ideas, are willing to implement a variety of pedagogical practices to better meet the needs of their students, and are more likely to have their students reach high academic standards.

Aderibigbe(2007), in her study entitled 'Science Laboratory Environment and Academic Performance' found that the science laboratory environment has a significant effect on the students' academic performance The results of the analysis also showed that there is a significant correlation between the type of science laboratory environment and students academic performance.

Kidman (2009) conducted a survey on 500 Australian students and their 35 teachers to find out the interest of students and teachers. The result of the survey showed that students and teachers had different opinions of what they considered important to be taught. The survey, conducted on the subject of Biotechnology in particular, also suggested that this must be the reason why most students drift away from the subject of science.

Cone (2009) explored the 'Effects of Community-Based Service- Learning (CBSL)' on 81 elementary science teachers and found that if the move is toward scientific literacy and equitable educational opportunities for all, it is important both theoretically and practically to understand the factors that contribute to positive changes in self-efficacy as it relates to teaching science for diversity.

2.3 Studies of Research in Science Education in India: A Macro Analysis:

In India, learning of Science has often been criticized as being too prescribed, impersonal, lacking in opportunity for personal judgment and creativity. There is a growing acceptance among Science Education Reformers that the process of doing science should not be separated from Scientific Content and that the aims of Science Education should be clearly spelt out. Research on Science Education has thus been mainly concentrated on :

- Environmental Studies
- Curriculum Syllabus and Text Books
- Learning Science and Models of Teaching
- Teaching Strategies
- Outcomes of Science Education (Scientific temper, attitudes, skills and interests)
- Correlates of Achievements in Science and,
- Educational Technology.

As found in Table-2.1, the Second Survey of Research in Education (1972-1978), science claimed significantly fewer studies. There were three studies (Veerapa, 1958; Patole, 1967 and Kelkar, 1950) that concerned themselves with the trend, course of study and teaching of science. The Third Survey of Research in Education showed that, out of the 15 research works related to science education, 4 were on Aptitude, 4 on curriculum and 5 on scientific thinking.

In the Fourth Survey of Research in Education, it was clearly shown that out of the 57 abstracts given on science education, 3 focused on attitude, 4 on aptitude, 11 on curriculum, 12 on method of teaching and one on scientific thinking and 13 on achievement. A study of the Fifth Survey of Educational Research revealed that of the 60 research projects on science education; 13 focused on attitude, 2 on aptitude, 4 on achievement, 8 on curriculum, 10 on method of teaching and 4 on scientific thinking while the rest focused on other aspects of science education. By the time the Sixth Survey of Research in Education came out(1993-2000), there had been considerable increase in Research on Science Education and the studies also showed wider variety indicating the growing interest of the Indian Academicians in Science Education. A total of 120 Researches in the field of Science Education could be recorded, almost double the number recorded in the previous survey.

Table – 2.1

Number of researches done on Science Education within India

Sl.No	Particulars	No. Of Studies on Science Education
1.	Second Survey of Research in Education (1972-1978),	3
2.	Third Survey of Research in Education (1978-1983)	15
3.	Fourth Survey of Research in Education (1985-1983)	57

4.	Fifth Survey of Educational Research (1983-1988)	60
5.	Sixth Survey of Educational Research (1993- 2000)	120

These five surveys clearly indicate that though researchers have not entirely neglected science education, the number still appears small in the context of India as having the second largest educational system in the world. The final tally of 120 studies is miniscule and does not favourably reflect on the existing and increasing growth in the number of schools, colleges, universities and institutions along with the large number of persons in the form of teachers, lecturers, readers, professors, full scale researchers and other academic staff who are involved in Science Education. Rather, most of them have focused on attitude, aptitude and achievement while neglecting to highlight the true status of Science Education in India.

2.4 Relevance of the Present Study in the Background of Studies Reviewed:

Analysis of these studies reveals that no study on the status of science education has yet been taken up in Mizoram. Even at the places where the topic has been touched, it was found that most often, only one aspect or another was touched. So far, no attempt has been made to have an overall study of different aspects of science education in one study. Therefore there was a need to look at the general status of science education in order to acquire a clear and comprehensive picture. Moreover, the variables and issues that the present study has addressed are completely different than issues addressed by previous researches.

It is expected that the outcome of this study will enable academicians and future research workers to understand where Mizoram stands in the field of science education. Not only this, it might be of immense value to policy makers and administrators in their endeavour to make correct judgement and right decisions. With all these in mind, the investigator thought it was necessary to look into the status of science education in Mizoram.

CHAPTER-III

METHODOLOGY

3.0 Introduction:

A sound methodology with effective procedure is vital for conducting any kind of research and facilitating the researcher to realize his or her goals. Besides, the reliability and validity of findings of research largely depend on the methodology adopted by the researcher. This chapter deals with various methodological issues such as method of study, population, sample, tools of data collection and analysis of data etc.

3.1 Method of Study:

After a careful deliberation, the investigator opted for the descriptive method of survey. This method is mainly used to describe and interpret what exist at present. Although it does not tell the reason why things are the way they are, by looking at the current situation indicated by the data collected beforehand, an investigator, by making use of this method can find out a number of facts that form the characteristic of a given situation and enables him or her to understand the practices in the given area.

3.2 Population:

Since this study was focused on the critical analysis of science education in Mizoram, the population for this study was comprising of all high schools, and higher secondary schools and colleges offering science. These educational institutes, as also reflected in Table-3.1 fall under the following three types of categories of management:

i) Government High Schools, Higher Secondary Schools and Colleges.

ii) Deficit High Schools and Higher Secondary Schools receiving grants under the deficit scheme under which teachers approved by the State Government receive the approved scale of pay.

iii) Private High Schools and Higher Secondary Schools receiving either annual block grant or receiving no grant at all.

Table 3.1
Details of Schools and colleges in terms of management (2006-2007)

Institutions	High schools	Higher Secondary Schools (with science)	Colleges
Government	192	11	6
Deficit	126	5	Nil
Private	184	11	Nil

Total	502	27	06

Sources: i)DSE ii)Controller of Examination, MZU.

The information regarding the number of high schools was obtained by the investigator after consulting the District Education Officers of all districts of Mizoram and the Statistical Wing of Directorate of School Education. At the time of the study, their records showed that there were 502 high schools and 95 higher secondary schools. However, only 27 of these schools offered science as a subject. All these schools were considered as population while collecting data for the present study. Moreover, it needs to be mentioned that out of 6 science colleges in the state, 2 are located in Aizawl, the capital city of Mizoram and remaining 4 science colleges are in Lunglei, Serchhip, Champhai and Kolasib. Three districts, namely, Mamit, Lawngtlai and Saiha do not have even a single college offering science subjects.

The information with regards to the number of colleges teaching science was obtained from the Directorate of Higher and Technical Education. At the time of the present study, there were 6 colleges offering science as a subject of study. All these institutions were taken as population for the study.

3.3 Sample:

Since the population for the present study was spread all over the state, a study of the location of schools, both secondary and higher secondary, was made. It was found that high schools, higher secondary schools were spread in the urban and semi-urban areas of different districts. It was also discovered that colleges offering science as a subject were located in the district capitals. Therefore, it was considered that Stratified Random Sampling would be most appropriate for the selection of sample. A detail of the samples as reflected in Table-3.2 has been given as under:

i) Sample of High Schools:

On the basis of the information covered out of the 502 high schools (which formed the population), 5% of these schools were selected as sample for the study. Accordingly, it was worked out that the sample numbers 25 high schools.

ii) Sample of Higher Secondary Schools:

For selecting samples for higher secondary schools, out of 27 schools that offered science as a subject of study, 15 schools were selected, representing 55% of the population.

iii) Sample of Colleges:

Since there were only 6 colleges offering science, all of these six colleges were included in the sample without further subjecting them to sampling.

Table – 3.2
Detail of Population and Samples

Educational Institutions	Population	Sample
High Schools	502	25
Higher Secondary Schools	95 (27with science)	15
Colleges	6 (with science)	6

Sources: i)DSE ii)Controller of Examination, MZU.

As indicated in Table-3.3, various institutions were distributed in all the 8 districts of Mizoram at the time this investigation was done. The investigator took utmost care to see that all the eight districts were represented for the present study. The same table clearly highlights the exact number of educational institutions representing each district within the state of Mizoram.

Table – 3.3
District wise Distribution of Sample

Name of District	High schools	Higher Secondary Schools with Science Stream	Colleges with Science Stream

	Population	Sample	Population (with Science Stream)	Sample	Population (with Science Stream)	Sample
Aizawl	187	8	19	9	2	2
Lunglei	88	3	2	2	1	1
Champhai	70	3	1	1	1	1
Kolasib	27	3	1	1	1	1
Serchhip	31	2	2	1	1	1
Mamit	30	2	Nil	Nil	Nil	Nil
Saiha	30	2	2	1	Nil	Nil
Lawngtlai	39	2	Nil	Nil	Nil	Nil
Total	502	25	27	15	6	6

Sources: i)DSE ii)Controller of Examination, MZU.

The sampling unit were educational institutions such as high school, higher secondary school and college. Since the population for the present study was spread all over the state, a study of the location of schools, both secondary and higher secondary, and colleges was made after availing the list of these institutions from different sources such as Mizoram University, Directorate of School Education, Directorate of Higher and Technical Education, and various District Education offices. It was found that high schools, higher secondary schools were spread in the urban and semi-urban areas of different districts and colleges offering science as a subject were located in the district capitals. As mentioned earlier, to draw an adequate and representative sample the investigator adopted the stratified random sampling to draw the sample of high schools and higher secondary schools from all the relevant districts. In case of Serchhip and Saiha districts, the concept of randomness was not applicable as both of these districts had only one higher secondary school each. A list of high schools and higher secondary schools selected as samples have been attached in Appendix-1 and Appendix-2 respectively.

3.4 Sources of Data:

For the present study, both primary as well as secondary sources were utilized in the collection of vital information regarding schools and colleges in Mizoram.

In order to make descriptions of the status of science education, the investigator collected a number of documents and records maintained by concerned government offices like Directorate of School Education, Directorate of Higher and Technical Education, Science Promotion Wing, State Council for Educational Research and Training, Mizoram Board of School Education, libraries, high schools, higher secondary schools and colleges. A survey of high schools, higher secondary schools and colleges was also made with the help of a check list and an interview schedule. The District Education Officers were all contacted so as to obtain the necessary data. Besides this, the investigator also made use of unstructured interview with various officials of the state government in order to have a better understanding of the situation and also to have a general idea of the attitudes of the people working for the development of science education within the state.

The investigator utilised all the available primary sources such as letters of correspondences in the office of the Directorate of School Education, Science Promotion Wing, Directorate of Higher and Technical Education, District Education Offices from all the 8 districts of Mizoram, Mizoram Board of School Education and all the 6 colleges offering science as a subject.

To find out the teachers profile at various stages from high schools to colleges, the incumbent records kept by District Education Officers and that of Directorate of School Education, Directorate of Higher and Technical Education were utilised. A data sheet where all the necessary details of science teachers in different institutions were reflected was maintained. This data sheet contained information regarding their educational qualification, age, gender, date of entry into service, extra qualification and professional degrees. A copy of this data sheet is attached in Appendix-3.

Pertinent information regarding results of examinations starting from HSLC till undergraduate University examination were obtained from the offices of Mizoram Board of School Education and Office of The Controller of

Examinations, Mizoram University respectively. Offices of the concerned colleges were also visited so as to ensure the accuracy of results obtained from the latter.

Information regarding the policies of the government with regard to science education was gathered from State Scientific Officer, Science Promotion Wing, records kept in colleges and libraries.

For finding out the various conditions as well as norm of practical work at various stages, the investigator made use of a checklist that was distributed to all the high schools and higher secondary schools. Besides this, an interview schedule was also prepared to find out a number of information that could not be covered by the checklist. The investigator also collected the time-tables followed by sample high schools, higher secondary schools and colleges.

For some general information, the investigator also made use of Statistical Handbook published by Directorate of Economics and Statistics, Mizoram Budget books and Economic Survey of Mizoram published by Planning and Programme Implementation Department, Government of Mizoram.

3.5 Tools of Data Collection:

For gathering information and data which cannot be obtained by records and interview with the concerned officers and staff, the investigator may employ several tools to make his or her investigation more accurate.

In the present study, the investigator had to collect certain information regarding various aspects of secondary, higher secondary and college education. The necessary information ranged from curricular to organizational aspects of each level of education. Two of the most important parts of the present research were to find out the laboratory condition as well as the way in which practical classes were followed. Since all of these needed a more structured approach, the investigator used two sets of tools. The tools used were ‘check list’ for high schools and higher secondary schools and ‘interview schedule’ for high schools, higher secondary schools and colleges.

3.5.1 Checklists for studying the Status of Science Laboratories in Schools:

A checklist may even be called a research administrator's best friend. As indicated by the name, a checklist is a list of items to be noted, checked or remembered. Often, research is hindered because of the presence of unimportant details that only serve to waste the researcher's time as well as the study itself. In this regard, a checklist is effective in research because it contains only the pertinent information. It not only saves time for the investigator but it carries information which cannot be misinterpreted because of its precise design.

In this case, there was no ready-made checklist. But a checklist was needed to find out the adequacy of the laboratory supplies at the high schools and higher secondary schools. The researcher found out that the Mizoram Board of School Education had made a list of required materials for secondary schools and higher secondary schools to be affiliated to it. To check the availability of required apparatus and chemicals etc., the investigator developed two separate checklists that were to be responded by the science teachers of selected schools. Copies of these checklists have been attached in the Appendix-4 and Appendix-5 respectively.

3.5.2 Interview Schedule for Science Teachers of Selected Secondary Schools, Higher Secondary Schools and Colleges:

The investigator developed a common interview schedule for sample high schools, sample higher secondary schools and colleges for collecting basic information with regard to their year of establishment, affiliation, starting of science courses, number of science teachers and laboratory attendants, number of students etc. The said schedule also carried questions relating to the adequacy of science classes and practical classes etc. This schedule was responded by science teachers of respective schools and colleges that constituted the sample of this study. A copy of this interview schedule has been given in appendix-6.

3.5.3 Reliability of the Interview Schedule:

Since the Interview Schedule was not prepared as test but was so constructed that obtained data must be considered in the light of many other factors, a single overall index of validity for the schedule could not be prepared. There are, however, ways to improve that validity of interview schedules and questionnaires. To ensure that the interview schedule measures what it proposed to measure, the following principles were kept in mind while selecting and framing statements:

1. It was ensured that items included in the schedule sample a different aspect of the purpose of investigation.
2. Various items used in the schedule were clearly defined to the respondents at the time of administering these schedules.
3. Suggestions from colleagues, supervisor and experts in the fields were elicited to remove the ambiguities in the questions.
4. It was ensured that the interview schedule covered reasonably well the range of variables under study.

3.5.4 Validity of the Interview Schedule:

The problem of estimating reliability of interview schedule is not quite the same as that of a test for which scores are obtained. As interview schedule in the present investigation was designed to analyse science education in Mizoram, the response to various items of these schedules do not necessarily reflect the intensities of the various activities and programmes. The responses to different items of the schedule are not scores in the usual sense of the term. Moreover, every item in this schedule is independent and measures a different dimension. Therefore, responses to the various items of reliability like split-half, alternate or parallel form and rational equivalence cannot be applied. However, to see that these schedules are reliable, the investigator applied 'test retest' method by administering these schedules twice on a small sample with a gap of two to three weeks and found them to be reliable.

3.6 Data Collection:

The interview schedule and the checklists were personally distributed to the sample high schools, higher secondary schools and colleges. The investigator also took extra care to reassure the schools that this study was not meant to check the capabilities of the school but to understand the real situation so as to enable the concerned officials to understand the true status of science education. The investigator here would also like to mention that while visiting the schools and colleges for the distribution and retrieval of data, she had a chance to have fruitful interaction with the staff and this considerably lightened her work.

As soon as data collection was completed, each school and college was given a code in order to make analysis easier. Finally there was a set of 25 checklists from high schools and 15 checklists from higher secondary schools. Accordingly, there were 25 interview schedules from the schools, 15 from the higher secondary schools and 6 from the colleges.

3.7 Tabulation of Data:

The data regarding the curricular, organisational and infrastructural condition of the educational institutions as received with the help of the checklists and interview schedule were first arranged into master tables according to the level of the institutions. All raw data were tested on the basis of the purpose for which they were gathered and only the useful and usable data were tabulated. The classified materials were recorded in accurate mathematical terms, that is, marking and counting frequency tallies for different items on which information was gathered. The raw data obtained through different tools were thus arranged in orderly columns and rows and then displayed in compact form, that is, in the form of statistical tables for further analysis.

3.7 Data Analysis:

The study being descriptive in nature, analysis of data was done with the help of descriptive statistics such as frequency distribution, percentage, cumulative frequency etc. Item wise analysis was mostly carried out.

Chapter-IV

SCIENCE PROMOTION WING

(Department of Science and Mathematics)

4.0. Introduction:

Several years after struggling with insurgency, Mizoram was established as a Union Territory of India in the year 1972. Education, especially science education, was one of the worst casualties with almost no infrastructure or teachers. Thus, it was considered important to have a special department with the sole purpose of developing science in the state. At that time, the government of Mizoram had just signed an agreement with UNICEF to improve and reorganize the teaching of science at the school stage. In order to implement the UNICEF project, the Science Promotion Wing was set up as a separate department under the Directorate of School Education as per the dictates of the Government of India. It was initially headed by a Science Promotion Officer, later on designated as Deputy Director in the year 1988.

Initially, the Wing operated almost entirely with the help of funds received from the UNICEF. The Project, intended to strengthen science education at the elementary stage was immediately carried out in 50 primary as well as 30 middle schools with pioneers like *C Hualkunga* and *Lalhmingthanga* as science consultants. Work was made easy under the able guidance of *A Sawihlira* who was the first Science Promotion Officer. In fact, *A Sawihlira* got the Padmashree award, India's fourth highest civilian award for his work on the practical science book 'Science is Doing'. The work was carefully supervised by the then Deputy Commissioner, *P. Rohmingthanga* IAS who took personal interest in the project hoping to realize his dream of making Mizo youth ready for the coming information technology revolution. All these set the tone for a grand campaign for science education throughout Mizoram, the Union Territory. The UNICEF Project was launched during 1973 to 1976 with the following objectives in mind :

1. To inculcate the spirit of scientific inquiry among students.
2. to develop the habit of scientific temper and attitudes in the minds of the students
3. To catch up with the development of science in advanced states.
4. To remove superstitions among the students through scientific means.
5. To produce technically qualified persons.
6. To promote science in higher learning.

Two years after its inception, the UNICEF called a conference in Calcutta in the year 1975. All the states of the north east were required to render a report of their progress in science education. The conference recognized Mizoram's progress as one of the fastest in the region. But these activities were mostly concentrated on science education at the primary level. It was only by the early eighties that secondary education was given more attention. When the erstwhile intermediate college was shifted to school education as higher secondary education or plus two indicating classes XI and XII, the Science Promotion Wing naturally spread its wings to take care of this section. Thus the wing now takes care of science education from the primary to higher secondary stages.

At present the Science Promotion Wing is attached to SCERT as the Department of Science and Mathematics. It proudly continues to be the main promoter of science and mathematics throughout the state of Mizoram. It works on the lines of the following objectives:

1. To review the existing curriculum in science and mathematics in order to generate a taste for learning.
2. To enhance teachers' professional competence by arranging suitable training programmes for teachers in science and mathematics from primary to higher secondary level.
3. To provide necessary equipment in science and mathematics laboratories for practical as well as demonstration purposes.

4. To train and encourage teachers to conduct demonstration of scientific experiments and mathematical concepts using inexpensive and indigenous equipment and materials besides laboratory work.
5. Provision for co-curricular activities such as organization of Science Exhibitions, Seminars, Eastern India Science Fair etc for promoting students interest as well as academic achievement in these subjects.
6. To provide incentive to meritorious students in the form of cash awards for proficiency in science and mathematics on the basis of public and promotion examinations.

This chapter has been sub-divided into three sections for a more convenient perusal of the status of the Department of Science and Mathematics, SCERT, which in turn should be able shed a light on the current status of science education within the state of Mizoram.

4.1 Allocation of Funds to Science Promotion Wing:

For the success of any project, besides human resources, financial resources play a key role. The first section has been devoted to the study of financial allocations made to the Science Promotion Wing so as to understand the extent of the Wing's abilities to promote science and mathematics throughout the state. After the UNICEF project was terminated, the state government continued to extend financial support to the Science Promotion Wing on a yearly basis. This has enabled the wing to carry on its work to promote science education at the school level throughout the state. A detailed account of financial allocations for the Science Promotion Wing made by the state government over the years is shown in Table 4.1.

Table-4.1 strongly indicates that the state government had been steadily increasing its financial support to the Science Promotion Wing so as to enable this wing to continue its various activities to generate and maintain interest in science education among students at the secondary level. However, one had to remember that a large chunk of these funds were utilized for the remuneration of staff. In fact, science equipment and materials were purchased only from the funds received under the planned heads. This again was sub divided into a number of heads like salary, medical treatment, office expenses, supply of materials, advertisement and publicity, incentive cash award, publication and other charges like annual state level science seminars, state level student science exhibition, Eastern India Science fair, computer training for teachers and training and workshop for science and mathematics teachers. The funds meant for supply of materials was further divided into three heads. The first head was for high schools and a total of 100 high school laboratories were supplied with new equipment each year. The second head was for higher secondary schools and 15 higher secondary schools were annually selected to be supplied with fresh apparatus and equipment. The third head was meant for this wing but this fund was utilized only when needed and did not make an appearance every year.

Table-4.1

State Allocation for Science Promotion Wing(1987-2008)

Year	**Budget (in lakhs)**		**Actual Expenditure (in lakhs)**	
	Plan	**Non-Plan**	**Plan**	**Non-Plan**
1987 - 1988	8.10	10.73	8.10	10.73
1988 – 1989	9.35	8.8	9.27	8.52
1989 – 1990	10.57	8.8	9.62	8.02
1990 – 1991	37.20	7.95	35.33	7.31
1991 – 1992	26.60	7.70	26.60	6.97
1992 – 1993	18.00	8.72	15.08	12.49
1993 – 1994	15.75	9.87	14.90	8.29
1994 – 1995	5.20	14.10	6.54	11.73
1995 – 1996	9.00	16.20	7.60	15.26

1996 – 1997	25.50	15.84	11.70	14.04
1997 – 1998	16.50	15.85	15.08	12.28
1998 – 1999	15.50	16.20	16.57	11.65
1999 – 2000	19.00	16.70	19.63	14.17
2000 – 2001	27.50	20.05	23.57	12.05
2001 – 2002	11.55	21.25	26.47	11.97
2002 – 2003	15.50	21.25	16.49	13.63
2003 – 2004	23.50	14.25	23.14	13.78
2004 – 2005	32.31	15.20	30.94	12.32
2005 – 2006	21.50	16.70	22.03	15.34
2006 – 2007	35.30	17.10	29.69	15.22
2007 – 2008	58.80	28.60		

Source : Demands for Grant, Govt. of Mizoram

4.2 Staffing:

Human resources also play an important part in the promotion of science education, may be even more so than the financial part. During the early times, it was not just the funds of the UNICEF but the enthusiasm of the science promotion officer and science consultants that lit the fire of science education. Therefore, the investigator considered it important to find out the current position of the Science Promotion Wing in terms of personnel. As expected, the wing was not exactly helpless in this area. It was taken care of by a total of 15 staff. The placement of staff during the time this investigation was made is reflected in table-4.2.

Table- 4.2

Staffing Position in Science Promotion Wing

Designation	Post(s) sanctioned	Post(s) filled	Vacancies
Deputy Director	1	1	-
Science Consultant	4	2	2
Programmer	1	1	-
Assistant Programmer	1	1	-
Projectionist	1	1	-
Computer Operator	2	1	1
Laboratory Assistant	1	1	-
Laboratory Attendant	1	1	-
Laboratory	1	-	1

Bearer			
Science Supervisor	2	2	-
Ministerial staff	2	2	-
Peon	2	2	-
Driver	1	1	-
Total	**20**	**16**	**4**

Source: SCERT annual reports

A close study of Table 4.2 reveals that there were some posts that were still left vacant. In view of the fact that only posts for 2 posts were filled up for 4 posts for science consultants, 1 in place of 2 posts for computer operator and that the post of laboratory bearer had been left vacant for some time, it was clear that this wing had not been fully attended to as it deserved to be. Although the presence of vacant posts could not be attributed as the culprit for the underdevelopment of any organization, it should be kept in mind that posts are created only to serve a purpose. So, an organization, in the absence of the required staff is like a body with vital parts missing. Therefore, the fact that even after more than 30 years, the wing was still allowed to operate with such a small staff was cause for worry.

4.3 Programmes and Activities for Science Promotion Wing

Although the UNICEF project is no more, it did leave an indelible mark in the history of science education in Mizoram. Till today, the Science Promotion Wing continues to make the scientific dreams of youngsters in Mizoram a reality. Some of the major activities carried out in order to implement the objectives of the Science Promotion Wing have been listed under the following heads:

4.3.1 Training of Science and Mathematics Teachers:

Teachers play a major role in qualitative improvement of science. Being the builders of the future generation, the teachers' quality needs to be maintained in such a way that even the ones teaching in the remotest area of the region is aware of new development in science and technology.

This wing regularly conducted short term training courses for science teachers to create awareness of methodology as well as content. These training courses mainly targetted primary, middle, high school teachers and in recent years, higher secondary school teachers. In the early years, teachers were given training in the following aspects:

-Objectives of UNICEF project

-Uses of science kits

-Method of teaching science

-Practical and demonstration in science

-Science hobbies and improvisation

-Scientific methodology

-Science corner.

Since the UNICEF project had terminated, the training courses were been to suit Indian policies. Trainings were considered even more vital for teacher development since the adoption of CBSE syllabus from session 2001. Table-4.3 reflects the status of training programmes conducted by the Science Promotion Wing for a period of 10 years (1999 to 2010).

Table-4.3

Training Progammes for Secondary School Science and Mathematics Teachers Organised by the Science Promotion Wing (1999-2009)

Year	Training of Secondary school Science and Mathematics Teachers						
	No of Programs Organised		Duration (In Days)		No. of Participants		
	Science	Math	Science	Math	Science	Math	Total
1999-2000	1	2	10	10	45	83	128
2000-2001	2	3	5	5	80	95	175
2001-2002	-	-	-	-	-	-	-
2002-2003	1	1	3	5	245	38	283
2003-2004	-	-	-	-	-	-	-
2004-2005	-	-	-	-	-	-	-
2005-2006	2		15	-	120		120
2006-2007	-	-	-	-	Not specified		200
2007-2008	-	-	-	-	Not specified		200
2008-2009	-	-	-	-	Not specified		200
Total	**6**	**6**	**-**	**-**	**-**		**1306**

Source: SCERT annual reports

As shown by Table-4.3, the Science Promotion Wing had been diligently organizing training programs for science and mathematics teachers. But may be due to lack of funds, the training programmes had not been organized every year. Besides this, during the year 2006 to 2009, the number of science teachers and mathematics teachers was not specified. So the investigator could not be sure whether the same number of science and mathematics teachers received training or not.

As reflected in the same table, for a period of 10 years, the Science Promotion Wing had trained a total of 1306 science and mathematics teachers teaching at the secondary level. It had also provided 6 rounds of training for science and mathematics teachers. But in view of the fact that this wing had the responsibility of taking care of the entire state, the number of trainings organized and the number of participants did not seem to be adequate.

Table - 4.4

Training Programs for Middle School Science and Mathematics Teachers Organized by the Science Promotion Wing (1999-2009)

Year	Training of Middle School Science and Mathematics Teachers						
	No of Programs Organized		Duration		No. of Participants		
	Science	Math	Science	Math	Science	Math	Total
1999-2000	1		10		44		44
2000-2001	-	Not specified		4		154	154
2001-2002	-	-	-	-	-	-	
2002-2003	1		1		70		70
2003-2004	-	-	-	-	-	-	
2004-2005	-	-	-	-	-	-	
2005-2006	1		1		50		50
2006-2007	-	-	-	-	-	-	
2007-2008	-	-	-	-	-	-	
2008-2009	-	-	-	-	-	-	
2009-2010	-	-	-	-	-	-	
Total	**3**				**164**	**154**	**318**

Source: SCERT Annual Reports

As shown by Table-4.4, it was clear that the Science Promotion Wing had also been giving training to middle school science and mathematics teachers. But this training was not provided since the last 4 years, i.e. 2007 to 2010. This could be either due to lack of funds or lack of interest in providing training to this level. Whichever may be the case, the fact that only a total of 318 middle school science and mathematics teachers had received training was not a good picture by any stretch of the imagination, especially considering the crucial nature of middle school education and its role in shaping the quality of students at the upper levels of education, the investigator did not think that just 3 trainings provided during a period of 10 years was enough to meet the professional needs of the teachers at this level of education.

4.3.2 Supply of Science Kits and Science Equipment:

Science, as we all understand, is a subject that can be better accomplished by doing. In order to make it interesting for students, the wing supplies science kits and other equipment as teaching aids to schools in need. At the middle section where laboratories were not provided, science kits were distributed so that science teachers could demonstrate to their students some simple scientific experiments that can be accomplished within the classroom itself. At the secondary section, provisions for laboratories were present. Therefore, science equipment that can be utilized to perform laboratory experiments were supplied. Since the establishment of higher secondary schools in the state, the wing also supplied science equipment, glass wares and chemicals to higher secondary schools.

As shown by Table- 4.4, which shows the number of schools that were covered within a period of ten years(2000-2010), the wing supplied science kits to 385 middle schools covering in different districts within the state in year 2000-2001. The same year, it also supplied science equipment to 108 high schools and

10 higher secondary schools. However, there was a gap of two years after which the Wing claimed that all schools from middle to higher secondary schools were covered. Thereafter, it did not supply such kits to the middle section of school education. However, high and higher secondary schools, except during the year 2009-2010, were continuously receiving science equipment from the Science Promotion Wing. Since most of the scientific equipments are perishable items, a yearly supply of equipment for science laboratory is a necessity and not a luxury. But till the last annual report, it was seen that schools did not receive regular supply of science equipment.

Table-4.5

Supply of Science Kits and Science Equipment by the Science Promotion Wing

Year	Supply of Science Kits and Science Equipment								
	Middle schools			High Schools			Higher Secondary Schools		
	Schools supplied	N	%	Schools supplied	N	%	Schools supplied	N	%
1999-2000	-	-	-	-	352		-		
2000-2001	385	1377	27.9	108	283	38.16	10	10	100
2001-2002	-	-	-	-	370		-		
2002-2003	-	-	-	-	409		-		
2003-2004	-	-	-	-	443		-	18	
2004-2005	-	-	-	All			All	16	100
2005-2006	-	-	-	327	502	65.13	12	25	48
2006-2007	-	-	-	200	508	39.37	15	22	68.18
2007-2008	-	-	-	200	502	39.84	15	25	68.18
2008-2009	-	-	-	100	521	19.19	10	27	37.03
2009-2010	-	-	-	-	-		-	30	

Source: SCERT annual reports

4.3.3 Organisation of Science Exhibitions:

Science exhibitions provide a chance for students and even the general public to find out more about science and the way it affects our everyday lives in a fun and informative manner. Not only this, it also encourages students to be more creative. Therefore, exhibitions are often arranged with a particular theme that would be able to inculcate in students a deeper appreciation for science along with a desire to learn more.

In order to develop scientific temper in students the wing has been organizing a state level science exhibition, sponsored by NCERT, New Delhi and Science Technology and Environmental Council, Mizoram, since the last 30 years. The winner of this exhibition is sent to represent the state at the national level science exhibition. The number of Science exhibitions organized by the Science Promotion Wing and the number of participants for a period of ten years is revealed in Table-4.6.

Table-4.6

Science Exhibitions Organised by the Science Promotion Wing (1999-2010)

Year	Organisation of Science Exhibitions					
	No of Science Exhibition Organised		Duration (in days)		No. of Participants	
	State	National	State	National	State	National
1999-2000	1	-	3		120	
2000-2001	-	-	-	-	-	-
2001-2002	-	-	-	-	-	-
2002-2003	1	1	3	5	-	69
2003-2004	-	-	-	-	-	-
2004-2005	1	-	1		70	-
2005-2006	1	-	2	-	67	-

2006-2007	1	-	3	-	25	-
2007-2008	1	-	3	-	**9 HS and 7 HSS (No of participant not specified)**	
2008-2009	1	-	3	-	90	-
2009-2010		-		-	-	-
Total	**7**	**1**	**18**		**372**	**69**

Source: SCERT annual reports

A look at Table-4.6 reveals that the Science Promotion Wing has been organizing science Exhibitions almost on a yearly basis. However, a look at the number of participants showed that only a handful of students participated in these exhibitions. Exhibitions are often expensive and most schools may not be able to provide the necessary funding. However, even with no model to show, students should be encouraged to be spectators. Only a total of 372 students had so far participated within the years under study. This was hardly sufficient coverage of students at state level.

4.3.4 Eastern India Science Fair:

Science fairs are one of the best learning experiences a student can undertake in order to become mature and have self reliance. This is why countries all over the world encourage science fairs. For students in an isolated state like Mizoram, this is an enriching programme because besides allowing students to explore their abilities, it gives them the necessary exposure to other places, schools and students.

Eastern India Science Fair is a fair organized in Kolkata every year by Birla Industrial and Technological Museum in collaboration with the state governments of eastern states with an objective of developing scientific temper and attitudes among students. Mizoram sends 25 students, along with 5 escort teachers to show their science models .One best model holder of each state receives a scholarship of Rs.200/- a month for one year and consolation prize is also awarded to certain deserving students.

A look at table 4.7 showed that even Mizoram had been taking part in science fairs at the national level. But throughout the years, not more than 25 students were able to participate in the science fairs. Besides this, only 5 teachers usually participated in the fairs. Therefore, the investigator thought that this was a very small number in consideration of the total population of students. A small total of only 145 students during a period of 10 years was hardly enough for a state like this.

4.3.5 Holding of Science Seminar:

Science seminars provide students with a chance to express their viewpoints on different issues in science education and have greatly helped them to develop scientific enquiry and analytical thinking. Seminars have been practiced at various levels according to the need of the students.

The Science Promotion Wing in collaboration with Birla Industrial and Technological Museum, Kolkata, has been organizing a district and state level science seminar every year. The best performer in the said seminar is recommended for participation in the National Level Science Seminar, New Delhi. The table- 4.8 highlights the number of programmes organized along with the number of participants for a period of ten years.

Table-4.7

Participation in Eastern India Science Fair Organised by Birla Industrial and Technological Museum, Kolkata (1999-2010)

Year	Eastern India Science Fair

	No of Programs Organised	Duration (in days)	No. of Participants	
			Students	**Teachers**
1999-2000	1	5	20	5
2000-2001	-	-	-	
2001-2002	-	-	-	
2002-2003	1	5	20	5
2003-2004	-	-	-	
2004-2005	1	5	20	5
2005-2006	1	5	20	5
2006-2007	1	-	20	
2007-2008	1	5	25	1
2008-2009	-	-	-	
2009-2010	1	5	20	
Total	**7**	**-**	**145**	**21**

Source: SCERT annual reports

A look at Table- 4.8 reveals that indeed The Science Promotion had been arranging Science seminars on a yearly basis although there were years when there was no report of science seminars. It had not only been able to organize it at the state level but also at the district level which ensures wider participation. But as seen from the same table, the Wing was only able to take part twice at the national level seminars. The total number of students who had participated in science seminars at the state level was only 67. This was a small number when the total population of students at high and higher secondary level is considered.

Although the Science Promotion Wing has so far been able to cover only a small number, it has the duty owing to its status as science promoter to show students science is not a subject to be feared but rather a subject which is fun, purposeful and enabling. Seminars are an inexpensive way of accomplishing all these tasks and it should not be neglected.

Table-4.8

Science Seminars Organised by the Science Promotion Wing(1999-2010)

Year	Holding of Science Seminar								
	No of Programs Organised			Duration			No. of Participants		
	District	State	National	District	State	National	District	State	National
1999-2000	1	1	-	1	1	-	-	8	-
2000-2001	-	-	-	-	-	-	-	-	-
2001-2002	-	-	-	-	-	-	-	-	-
2002-2003	1	1	-	1	1	-	40	9	-
2003-2004	-	-	-	-	-	-	-	-	-
2004-2005		2	1	-	-	1	-	11	1
2005-2006	1	1	-	-	1	-	-	9	-
2006-2007	-	-	-	-	-	-	-	-	-
2007-2008	-	1	1		1	1	-	-	1
2008-2009	-	1	-	-	1	-	-	14	-
2009-2010	-	1	-	-	1	-	-	16	-
Total	**3**	**8**	**2**	**2**	**6**	**2**	**40**	**67**	**2**

Source: SCERT annual reports

4.3.6 Cash Awards:

Cash awards are mostly insufficient to meet the total financial requirement of students. But they play an important part in inspiring students to pursue further education in science. Furthermore, the number of individuals awarded each year also reveals the quality of students since they were awarded only to those students who have performed better than average in science and mathematics.

The School Education Department has a provision of cash award as incentive to meritorious students of primary, middle and high school students for their proficiency in science and mathematics. The award is based on their performance in board examination at PSE, MSLC, and HSLC and promotion examination of class VIII and IX. Table-4.9 gives a detail of the number of students who have received cash awards during the years 1999 to 2010.

Table-4.9

Numbers Students Given the Cash Awards by the Science Promotion Wing

(1999-2010)

Year	Numbers Students Given Cash Awards
1999-2000	225
2000-2001	297
2001-2002	-
2002-2003	212
2003-2004	-
2004-2005	206

2005-2006	217
2006-2007	-
2007-2008	240
2008-2009	240
2009-2010	232
Total	**1849**

Source: SCERT annual reports

A look at Table-4.9 reveals that The Science Promotion Wing had been organizing cash awards for its meritorious students almost on a yearly basis. However, it does not clearly specify the number of middle school, high school and higher secondary school students who had received the award. But even without this knowledge, a total of 1829 was a small number if it was for a span of 10 years. A total of 297 students were awarded in the year 2000-2001 but in all the other years under study, the students were lesser in number.

4.3.7 Improvement and Establishment of Science Laboratories:

Science laboratories are a necessary part of science education. Unlike other subjects, mere theoretical knowledge is not sufficient. It is only through practical work that the true essence of science education can be felt. With this in mind, science laboratories are considered as one important feature in order to be recognized by the Mizoram Board of School Education.

The Wing, depending on the availability of funds, provides fund to schools to build their science laboratories and furniture. However, there have been years when no school was assisted as no separate fund was allocated by the state government, to the wing for this purpose.

As no clear data was available so as to fully understand the amount that have been spent and the number of schools that have been covered, the investigator could only assume that the Wing would be doing its best to improve science laboratories from high school till higher secondary schools.

4.3.8 Computer Education:

The wing established a computer cell in 1989 with a view to create computer awareness in students. This cell has been coordinating CLASS (Educational Technology and Computer Literacy and Studies in Schools) project under CSS and computer in schools under NEC Shillong. Computer training has also been conducted for elementary and high school teachers. This project has now been implemented in 84 schools. However, with the initiation of a separate department of information and Communication Technology in the year 2004, this responsibility has now been lifted off its shoulders.

4.3.9 Centrally Sponsored Scheme for Improvement of Science Education in Schools:

This Centrally Sponsored Scheme for Improvement of Science Education in Schools, introduced in Mizoram since 1987-88 had the following components:

a) **Provision of Science Kits and Equipments and library books to Schools**: As stated earlier, science kits and equipment are essentials that science education cannot do without. In recognition of this, the Science Promotion Wing reserves certain funds under the Centrally Sponsored Scheme to provide better scientific equipment to schools. Besides this, library books are also supplied with a view to broaden the students' outlook. Table-4.10 provides a detail of schools covered within the year 1999-2000 after which details of fund utilization was not written in any of the records.

Table-4.10

No. of Schools Given Science Equipment by the Science Promotion Wing

Year	Science Kits	Science Equipment	Library Books
	Middle Schools	High & Higher Secondary Schools	High & Higher Secondary Schools
1999-2000	210	129	129

Source: SCERT annual reports

As shown by Table-4.10, in the year 2000-2001, a total of 210 middle schools were provided with science kits. Since there were 851 middle schools at this time, it meant that only a small portion was covered. In the same year, a total of 129 high schools out of 370 high schools were given science equipment, again a small number in consideration of the total population. A total of 129 schools were provided with library books but the number of books supplied along with the amount spent was not highlighted. No record of accomplishment through Centrally Sponsored Scheme was found in the later years.

b) **Organisation of Training Programme for Science and Mathematics Teachers of various Categories of Schools in Mizoram under the Scheme**: The Centrally sponsored scheme also covered the training of teacher but a detailed account was not made available through the annual report of achievements.

4.3.10 Supervision of Schools:

Officers of the Wing visited the schools from time to time to ensure the effective utilization of science kits and equipment supplied by the wing as well as to sort out the problems faced by schools in the establishment of science laboratories. However, during the years under study, there was no record of school inspection made by the Science Promotion Wing.

4.4 Conclusion:

A look into the annual reports of SCERT revealed that although the Science Promotion Wing was doing its best to promote science education, it had not expanded much in terms of student activities and incentives. No new activity had been added to its curriculum in order to strengthen students' interest in science or to generate a more competitive spirit in science. Besides this, training of teachers, what used to be one of the most important activities of this wing did not seem to occupy its former place of importance. Although it still took place, it was mostly done by calling the teachers to the headquarters rather than the consultants visiting the villages as was done in the earlier times.

A unstructured interview with the Deputy Director in charge of this wing revealed that one reason this wing has not been able to perform as it used to back in the past may be because it functioned as just a small wing under the SCERT. According to the Deputy Director, this kind of wing should be allowed to function as a separate directorate and not as a part of a bigger department which has so much on its plate. The Government of Mizoram, if it is considering any modification or remedial measures for science education, might need to keep this in consideration.

At the same time, the researcher had her own reservations with regards to a purely independent directorate for science education at the middle and secondary level. It would not only take up too much of the state's already meager resources but could also set a wrong precedent in the SCERT. However, an increase in the allocation of funds would create a good deal of positive changes in the department. It would mean that the wing would be in a comfortable position to fill up vacant posts, perform better in its activities and generally strive to make science education at the school level as progressive as possible.

145

CHAPTER-V

Status of Laboratories, Practical Activities and Time Tables

5.0 Introduction:

The importance of good practical work is widely accepted. *It has been acknowledged that good quality practical work promotes the engagement and interest of students as well as develop a range of skills, science knowledge and conceptual understanding*[9]. It has been observed that it is important to support and promote practical work in science because it:

- Stimulates creativity, curiosity and critical thinking
- Underpins and illustrates concepts, knowledge and principles
- Promotes student engagement with the scientific method
- Encourages active learning and problem-solving
- Allows collaborative working
- Provides opportunities to collect and analyse data and apply mathematical skills.

This does not mean that theory is less important, but that practical work and theory should go hand in hand in order to induce wholesome uncerstanding of science which cannot be achieved with theory alone.

5.1 Rules and Regulations for Affiliation of Science Courses at Different Levels of Education:

According to the National Curriculum Framework 2005, secondary education should be a time to give students a learning experience where they can have a chance to work with their hands and in activities and analysis on issues surrounding environment and health. Systematic experimentation as a

[9] Practical work in science: a report and proposal for a strategic framework; SCORE(Science Community Representing Education), 6-9 Carlton House Terrace, SW1 Y5AG, 2008.

tool to discover/ verify theoretical principles, and working on locally significant projects involving science and technology are to be important parts of the curriculum at this stage. At the higher secondary stage, science should be introduced as a separate discipline with emphasis on experiments and problem solving. Science should be a means to stimulate students' creativity and inventiveness.

In accordance to this, the Mizoram Board of School Education has laid down the following rules with regard to infrastructure, equipments, teaching aids, etc for science education at the secondary and higher secondary stages.

A) Rules with Regard to Infrastructure, Equipment, Teaching aids, etc for Science Education at the Secondary Stage:

A High School offering subjects with practical shall have the following infrastructure, equipments, teaching aids, etc, whichever is applicable as listed below or as per the prescription of the Board from time to time:

(i) A laboratory room to conduct science practical, (Physics/Chemistry/Biology) accommodating a minimum of 20 students at a time, providing a minimum carpet area of 20 (twenty) Square feet per student with necessary equipment.

(ii) A separate room each for Physics, Chemistry and Biology is desirable.

B) Rules with Regard to Infrastructure, Equipment, Teaching aids, etc for Science Education at the Higher Secondary Stage:

Higher Secondary Schools offering subjects with practical shall have the following infrastructure, equipment and teaching aids, etc., whichever is applicable as listed below or as per the prescription of the Board from time to time:

(i) A laboratory room to conduct Physics practical, accommodating a minimum of 24 students at a time, providing a minimum carpet area of 20 (twenty) square feet per student with necessary equipments.

(ii) A laboratory room to conduct Chemistry practical, accommodating a minimum of 24 students at a time, providing a minimum carpet area of 20 (twenty) square feet per student with necessary equipments .

(iii) A laboratory room to conduct Biology practical, accommodating a minimum of 24 students at a time, providing a minimum carpet area of 20 (twenty) square feet per student with necessary equipments

(iv) A store room measuring a minimum carpet area of 256 (Two hundred fifty six) square feet, for the laboratory or laboratories to store respective practical instruments /chemicals /equipments with proper inventory and recording registers.

The above is just a minimum requirement that should be met. This requirement has been clearly laid down by the Mizoram Board of School Education and based on their stipulations for schools who desire to be affiliated to it, the investigator thought it necessary to find out the condition of laboratories in secondary and higher secondary schools.

For this, the investigator thought it was appropriate to select certain schools from government, deficit and private schools as sample for the study. After careful study of schools in different part of the state, 15 higher secondary schools were selected and 25 secondary schools were selected as samples. These made up 5% of the total number of schools.

A checklist containing items laid down by the Mizoram Board of School education was prepared and the investigator visited each of the schools to make sure the responses were made and that they were correct. The following tables show the result of this checklist.

C) Rules with Regard to Infrastructure, Equipment, Teaching aids,etc for Science Education at Higher Education:

As found in the section ‘on affiliation of colleges’ of Mizoram University, the affiliating body for colleges in the state of Mizoram, colleges offering science need to meet the following terms in order to secure affiliation from the affiliating body:

-For Three Year Degree Course (General), the number of students to be admitted to a degree programme in Science shall not ordinarily exceed 40 in each section.
-the number of students for a practical class shall not exceed 20 under any circumstances.
-In case, the number of students exceeds the prescribed limit the class shall be split into two or more sections so as to bring them within the prescribed norm.
-For three Year Degree Course (Honours), the number of students to be admitted to a degree programme in Science shall not ordinarily exceed 25. In case, the number exceeds the prescribed limit the class shall be split into two or more sections so as to bring them within the prescribed norms.
-The number of students for a practical class however shall not exceed 15 under any circumstance.
- For Science subject there shall be separate Lecture theatre and laboratory rooms with the provision that no student will have less than 2.2 sq. metre floor area for working in the laboratory.

No check list as was prepared for high schools and higher secondary schools could be prepared because the University did not lay down any specifications with regards to the number, amount and quality of apparatus, equipment or materials needed in the laboratories.

5.2 Status of Science Laboratories at Secondary, Higher Secondary and Collegiate Level:

5.2.1 Status of Science Laboratories in High Secondary Schools:

5.2.1.1 Physics

(a) Apparatus and Equipment:

As revealed by Table- 5.1, the apparatus and equipment for practical work in physics was hardly satisfactory at the time the investigation was done. Equipment like concave mirror, convex mirror and plane mirrors were present in more than 80% of the sample high schools. However, galvanometers, horse shoe magnets, maximum and minimum and testers- all of them being important parts of practical works- were present in less than 50% of the sample high schools. It was also seen that materials like magnetic needle, clinical thermometer and electromagnet were present in less than 30% of the schools. It was sad to find that Steel almirahs were absent in 78% of the sample high schools and experiment table were absent in 36% of the sample high schools.

Table-5.1
Percentages of Sample High Schools having Specified Apparatus and Equipment in Physics in Sample High Schools(N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Concave mirror FL-15cm	21	84	04	16
2	Convex mirror 5mm dia FL-10cm@FL20cm	21	84	04	16
3	Plane mirror, 10cmx5cmx3mm	22	88	03	12
4	Convex lens plano FL10cm, FL50cm	18	72	07	28
5	Glass Prisms (equilateral 40mmeach side)	21	84	04	16
6	Glass slab (7.5x5x1.25cm)	19	76	06	24
7	Slide callipers	14	56	11	44
8	Rheostat	19	76	06	24
9	Voltmetre DC with stand, 0-10 volts	18	72	07	28
10	Ammeter with stand DC 0-5 MA	18	72	07	28
11	Galvanometer, weston type	12	48	13	52
12	Physical balance(double pan balance with glass case)	16	64	09	36
13	Concave lens, plano 5cmm dia	20	80	05	20
14	Bar magnet 100m length/alnico, 75mm length	18	72	07	28
15	Horse shoe magnet	13	52	12	48
16	Electromagnet	7	28	18	72
17	Magnetic needle	9	3	16	64
18	Metallic bob, pendulum bob with hook	14	56	11	44
19	Clinical thermometer	8	32	17	68
20	Tuning fork-340hz, 480hz,256-512 hz	10	40	15	60
21	Resistance wire, eureka constant 225 w	5	20	20	80
22	Maximum and minimum thermometer	12	48	12	48
23	Steel almirah 6x3	7	28	18	72
24	Stop watches 0-60secx1/5 sec	15	60	10	40
25	Tester,(electric)	11	44	14	56
26	Multimeter(analogue)	9	36	16	64
27	Battery eliminator	12	48	13	52
28	Extension cord(ISI mark with indicator)	10	40	15	60
29	Flexible wire (0.44mm copper)coil	9	36	16	64
30	Experiment table, 6x4	16	64	09	36

Table-5.2 shows that among the schools where the science apparatus and equipment were found, only 32 % of them had more than 75% of the specified apparatus and equipment. Another 32% had more than 50 % but this was not sufficient for the conduction of a successful physics practical. The fact that 28% of the schools still had less than half of the required apparatus and equipment was certainly not a picture expected of a progressive state. Still worrying than this was that 2% of the schools still had less than 25 percent of the required apparatus and equipment. The above statistics clearly showed that secondary schools in all of the eight districts still functioned much lower than expected in terms of practical work.

The cumulative percentage indicates clearly that while no school had absolutely no apparatus nor equipment, 8% of the schools carry on laboratory work with a bare minimum of 25% of the required materials. A slightly better figure of 36% was the percentage of schools that had between 25% to 50% of the required apparatus and equipment. But it was sad to note that it was less than 68% of the schools that still operated their laboratories with not more than 75% of the required apparatus and equipment.

Table-5.2

Availability of Specified Apparatus and Equipment in Physics in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	8	32	25	100
50%-75%	8	32	17	68
25%-50%	7	28	9	36
Below 25%	2	8	2	8
Nil	0	0	0	0

If this was the amount of equipment present in the schools, there certainly is no hope for good scientific experiments that would give the students sound grounding in science education. It may also be interpreted that most of the schools still depended on theoretical knowledge to learn science because they did not have the required materials to perform qualitative laboratory work.

5.2.1.2 Chemistry:

(a) Apparatus and Equipment:-

Table-5.3

Percentages of Sample High Schools having Specified Apparatus and Equipment in Chemistry Laboratory (N=25)

S.l.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Beakers borosil-500ml,250ml,100ml	24	96	01	4
2	Conical flask borosil-250ml, 100ml	21	84	04	16
3	Testtube borosil-20ml	24	96	01	16
4	Glass funnel, big and small	24	96	01	16
5	Glass rod-300mlx10mm(bundle of 50)	22	88	03	12
6	Glass tube- 300x5mm(bundle of 50)	18	72	07	28
7	Measuring cylinder, borosil glass upto 500ml	19	76	06	24
8	Spirit lamp, brass, good quality, hard	20	80	05	20
9	Tripod stand, triangular top iron 9mm	23	92	02	80
10	Test tube holder, iron , good quality	18	72	07	28
11	Test tube stand(plastic, at least 10 holdes)	22	88	03	12
12	Weight box	19	76	06	24
13	A pair of tongs	12	48	13	52
14	Wire gauge, asbestos coated	17	68	08	32
15	China dish, 70mm dia	22	88	03	12
16	Dropper(5ml holder)	20	80	05	20
17	Volumetric flask, borosil-500ml, 250ml	8	32	17	68
18	Filter paper, standard quality	20	80	05	20
19	Funne;l stand with ring clamp	11	44	14	56
20	Ball and stick model, plastic set	8	32	17	68
21	Hypodermic syringe, plastic-2ml holder	3	12	22	88
22	Glass trough	7	28	18	72
23	Beehive shelf	4	16	21	84
24	Gas jar	12	48	13	52

As seen in Table-5.3, the sample high schools were quite poorly equipped when it came to apparatus and equipment. At the time the study was done, essential items like beakers, conical flasks, glass rods, test tubes, china dish, and tripod stands were present in more than 80 % of the sample high schools. Although this looked reassuring, it meant that more than 20% of the sample high schools did not have these essential items. Items like tongs, funnel stands, volumetric flasks and gas jars were present in less than 50% of the sample schools but the other picture was that nearly 50% of the schools did not have these items.

Table-5.4
Availability of Specified Apparatus and Equipment in Chemistry in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	10	40	25	100
50%-75%	12	48	15	60
25%-50%	2	8	3	12
Below 25%	0	0	1	4
Nil	1	4	1	4

Table-5.4 is clear indicator of the poor condition that secondary schools in Mizoram were allowed to exist. Only 40% of the sample high schools had more than 75% of the required apparatus and equipment in chemistry. A slightly better but nonetheless unhealthy picture was shown by 48% of the schools who had 50% to 75% of the required apparatus and equipment. The fact that 8% of the sample schools had 25% to 50% of the prescribed apparatus and equipment was bad enough, that 4% of the sample schools had none of the prescribed apparatus and equipment was cause for serious concern for science education at the secondary stage.

The frequency percentage clearly indicated that less than 60 percent of the sample high schools had more than 50% of the required apparatus and equipment in chemistry. Even a 50% is still not sufficient to run a good laboratory. Not only will the students be prevented from performing their own experiment but even the teacher will be unable to demonstrate all the necessary experiment for the benefit of the students due to lack of materials. Less than 12% of the sample schools had more than 25% which in reality was not a good amount for even a mediocre laboratory. That 4% of the schools still remained with less than 25% of the required materials and another 4% still remained without a single laboratory apparatus and equipment to show should be a reminder for every educational administrator, concerned school as well as society to be more vigilant of the changes needed to be brought in secondary schools in the state. If the situation is allowed to continue, science will just be a collection of difficult concepts for students and most will choose to opt for other streams when they come to the stage when they can choose among various disciplines.

(b) Chemicals :-

Table-5.5
Percentages of Sample High Schools having chemicals in Chemistry in Sample High Schools(N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Colbalt nitrate	6	24	19	76
2	Anhydrous copper sulphate	14	76	11	24
3	Common salt	13	52	12	48
4	Ammonium chloride	19	76	6	24
5	Acetic acid	19	76	6	24
6	Ammonia soln	13	52	12	48
7	Copper sulphate crystal	14	56	11	24
8	Calcium carbonate	17	68	8	44
9	Copper metal turning	18	72	7	28
10	Formaldehyde	15	60	10	40
11	Ferrous suphate	13	62	12	38
12	Ethyl alcohol absolute 99.9%	10	40	15	60
13	Hydrogen peroxide	9	36	16	64
14	Hydrochloric acid, concentrated	21	84	4	16
15	Iron metal powder	12	48	13	52
16	Iodine	20	80	5	20
17	Magnesium sulphate	9	36	16	64
18	Manganese dioxide	8	32	17	68
19	Mercuric chloride	2	8	23	92
20	Magnesium chloride	8	32	17	68
21	Nitric acid, concentrate	18	72	7	28
22	Pottasium chloride	12	48	13	52
23	Pottasium permanganate	15	60	10	40
24	Phenolpthalein	14	56	11	44
25	Sodium bicarbonate	17	68	8	32
26	Sodium carbonate	15	60	10	40
27	Sodium nitrate	10	40	15	60
28	Sodium hydroxide	18	72	7	28
29	Sodium metal	10	40	15	60
30	Starch soluble	10	40	15	60
31	Silver nitrate	8	32	17	68
32	Sulphuric acid, concentrated	21	84	4	16
33	Zinc sulphate	12	48	13	52

34	Zinc chloride	9	36	16	64
35	Zinc metal	15	60	10	40
36	Zinc carbonate	7	28	18	72

As shown by table-5.5, chemicals like hydrochloric acid, anhydrous copper sulphate, iodine, sulphuric acid and nitric acid were the only chemicals which were present in more than 70% of the sample high schools. But it should not be forgotten that these chemicals were absent in nearly 30% of the sample high schools, a large number considering the vital role they play in experiments. Some of the chemicals like formaldehyde, ferrous sulphate, calcium carbonate, pottasium carbonate and sodium carbonate were present in 60%, 62%, 68%, 60% and 68% respectively. However, chemicals like silver nitrate, zinc carbonate magnesium dioxide and cobaltous nitrate were present in only less than 35% of the sample high schools.

Table-5.6
Availability of Specified chemicals in Chemistry in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	8	32	25	100
50%-75%	4	16	17	68
25%-50%	8	32	13	52
Below 25%	4	16	5	20
Nil	1	4	1	4

Chemicals are a necessity in chemistry laboratory. They are the one area where no compensation can be made because reactions are changed with the absence or presence of one chemical. While some compromise can be made in the case of furniture or equipment, chemical reactions cannot be carried out unless all the required chemicals are present if the desire is to get accurate results. Therefore, the fact that only 32% of the sample high schools had more than 75% of the required chemicals in chemistry as shown in table-5.6 was not a good image. Only 16% of the sample schools have 50% to 75% of the required chemicals. Another 32% of the selected schools had 25% to 50% of the prescribed sample. Last but not least, 4% of the sample high schools still had no chemicals to carry out experiments. This showed that for most schools in Mizoram, science education was just a futile attempt and does not really have a chance to plant the seeds of interest in science in the young minds that make up the population of students in the secondary stage.

Therefore, the fact that 68% of the selected schools had less than 75% of the required materials was worrying. That less than 52% had less than 50% of the specified chemicals was reason enough to embark on a deeper study of supply modes as well as the sum allotted to secondary schools for the development of science education. The fact that 4% of the schools still remained with no chemicals for chemistry was reason to be truly ashamed, both for teachers as well as government. Considering the fact that laboratory practical works carry 25% of the marks in science at the secondary level, the existence of schools with no chemicals to carry out laboratory work showed the negligence of teachers as well as government.

5.2.1.3 Biology:

(a) Apparatus and Equipment:-

Table-5.7

Percentages of Sample High Schools having Specified Apparatus and Equipment in Biology Laboratory (N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Mortar and pestle, medium size	21	84	4	16
2	Pippette,borosil-10ml	15	60	10	40
3	Dissecting tray(300mmx250mmx65mm-complete white enameledwith wax, good quality)	10	40	15	60
4	Dissecting bbox(comprising 14 instruments, stainless steel-good quality)	12	48	13	52
5	Compound microscope(standard quality eye piece 10x5 magnification 100x675 with box, lock and key)	21	84	4	16
6	Simple/dissecting microscope(good quality)	12	48	13	52
7	Hand lens(sample required)	18	72	7	28
8	Glass slides box(13mmx108mmx38mm standard and index sheet with blue star)	18	72	7	28
9	Cover slip(optically flat in log pack rectangular 20)blue star	17	68	8	32

10	Permanent slides with labelled boxes	17	68	8	32
11	Watch glass, heat proof, transparent and 60,80 diametre	11	44	14	56
12	Charts- vitamins, food chain, food web	13	52	12	48
13	Wide mouth bottle, good quality, 1000ml	7	28	18	72

As indicated by the Table-5.7, among the few apparatus and equipment outlined by the MBSE, only mortar and pestle and compound microscope were the only ones present in more than 80% of the sample high schools. The data showed that items like permanent slides, cover slips, pipette, etc were absent in nearly 50% of the sample high schools. Since biology deals with organic matters, proper apparatus and equipment is a must. Hence it does not bore well for the schools to have such poorly equipped laboratories in this day and age when all states in different regions are on a forward march for development in science education.

Table-5.8
Availability of Specified Apparatus and Equipment in Biology in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	7	28	25	100
50%-75%	9	36	18	72
25%-50%	6	24	9	36
Below 25%	1	4	3	12
Nil	2	8	2	8

Biology is a delicate subject that needs constant supply of materials because many of the apparatus used have a life time and need to be replaced in regular intervals. Due to this it need a dedicated effort in terms of finance and human resource in order to keep it in working condition. Table-5.8 here showed that only 28% of the sample high schools had above 75% of the required apparatus and equipment. It also revealed that only 36% of the high schools selected as sample had 50% to 75% of the required materials. But as mentioned earlier, it would not be possible to carry out all the biological experiments with just 50 to 70% of the required materials. Besides this, 24% of the schools had less than 50% and slightly more than 25%. It was clear that they too will not be able to run a successful biological laboratory. But that 4% of the schools still had less than 25% of the specified apparatus and equipment and that another 8% of the schools still operated their biology classes with no practical work was cause for serious concern for the future of science education. It was obvious that these schools only depended on theoretical knowledge for their students to learn science and they had no chance to understand the beauty of the subject in a practical manner.

The cumulative percentage showed that 72% of the selected sample high schools still had less than 75% of the required apparatus and equipment. Based on this fact, it could also be concluded that 72% of the sample high schools still managed with less than 75% of the required apparatus and equipment. This means that 75% of secondary students will have no opportunity to carry out 75% of the laboratory work. Among this group who had less than 75% of the required apparatus and equipment, 36% have less than 50% of the required apparatus and equipment. This clearly showed that 36% of the sample secondary schools had less than 50% of the required apparatus and equipment to accomplish their allotted laboratory work. That 12% of the sample high schools still had less than 25% of the required apparatus and equipment was sad, but that 8% of the sample schools had no apparatus nor equipment but were still allowed to sit for an examination where 25% of the full mark went to practical work was enough reason to be truly concerned about the current state of affairs and start taking positive steps if one is in the position to do so.

(b) Charts :-

Table-5.9
Percentages of Sample High Schools having Specified charts in Biology Laboratory (N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Charts-Cell division (Mitosis & Meiosis)	16	64	9	36
2	Plant Cell & Animal Cell	14	56	11	44
3	Charts, Model, Diagrams, Specimen of Ancestral forms of Man, Canine & Incisors, Hands of Man & Monkey	4	16	21	84

4	Chart/Diagram-Microscope (Compound & Simple)	7	28	18	72
5	Chart-Human Heart, Reproductive System, Urinary System, Kidney Section	13	52	12	48

Charts tell wonderful stories to students and can accomplish what lengthy lectures fail to achieve. This is why meaningful charts should always be a part of good practical work in science. Table-5.9 here showed that out of the 5 charts, only the charts showing cell division, plant cell, and human heat, reproductive system, urinary system and kidney section were present in more than 50% of the schools. Charts showing models of ancestral home sof man, canine and incisors, hands of man and monkey and diagram of microscope were present only in 16% and 28% respectively. If this was the condition, most of the high schools in Mizoram was not able to provide the right environment for inculcation of scientific attitude in their students.

Table-5.10
Availability of Specified Charts in Biology in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	6	24	25	100
50%-75%	6	24	19	76
25%-50%	4	16	13	52
Below 25%	1	4	9	36
Nil	8	32	8	32

As shown in Table-5.10, 25% of the schools selected as sample high schools had 75% of the required charts. Considering that only 4 different charts were demanded, this was a small number. Even a 100% would not be difficult to attain since charts are easy to obtain. In spite of the fact that charts are one of the least inexpensive items, 24% of the sample schools had 50% to 75% of the required charts only. While 16% of the sample high schools had 25% to 50% of the required charts, 4% had less than 25% of the required charts for biology practical. But the real shame was that 32% of the sample schools did not have any chart. This was indeed poor because charts could be used not only in the laboratory but during class lectures because pictures often spoke louder than words especially in science subjects. In any case the fact that they were so easily available in the common market was reason enough for most schools to acquire them but this did not seem to be the case in the case of secondary schools in Mizoram.

The cumulative percentage also revealed without a doubt that 76% of the sample schools had less than 75% of the required charts. At this point, the investigator would also like to mention that even in the schools where charts were present, they were neatly rolled up and students were even asked not to touch them, let alone study them. Since this did not seem to be the reason why the MBSE demanded charts to be present in the schools, it was really disheartening to see schools not utilizing the charts which are one of the easiest ways to make students understand scientific facts. Besides this, 52% of the sample high schools had less than 50% of the required charts. But 36% of the sample high schools still had less than 25% of the prescribed charts. All these were bad news for a state whose desire was to make maximum use of its human resources to make up for its lack of physical resources but worse than these schools are the rest 32% who have no chart at all. This is not just negligence but sheer ignorance as well. If after more than a decade of living in the 21st century, we still had schools like this the investigator wondered if the state would ever have schools worthy of excellence in science education.

(c) Chemicals :-

Table-5.11
Percentages of Sample High Schools having Specified chemicals in Biology Laboratory (N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Dpx mountant	7	28	18	72
2	Conc.H Cl	18	72	7	28
3	Methylene blue	12	48	13	52
4	Suffranine	18	72	7	28
5	Iodine soln.	19	76	6	24
6	Distilled water	13	52	12	48
7	Conc. HNO3	17	68	8	32
8	Ammonium hydroxide	15	60	10	40
9	Burette reagent	12	48	13	52
10	Millon's reagent	16	64	9	36
11	Sudan III	17	68	8	32
12	Formalin	14	56	11	44
13	Eosin	11	44	14	56

14	Ammonium chloride	15	60	10	40
15	Cotton blue	8	32	17	68
16	Zinc metal	14	56	11	44
17	Marble chips	13	52	12	48

As evident in Table-5.11, vital items like Dpx mountant and cotton blue were present only in 28% and 32% of the sample high schools respectively. Only a few items, namely, suffranine, concentrated hydrochloric acid and iodine solution were found in more than 70% of the sample high schools. The rest of the specified chemicals like distilled water, nitric acid, formalin, zinc metal and marble chips were absent in nearly 50% of the sample high schools. In fact, none of the items were present in all of the sample high schools. Considering the importance of these chemicals, their absence in many of the sample high schools show that practical activities in biology will certainly not be as visualized by the MBSE.

Table-5.12
Availability of Specified Chemicals in Biology in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	**Frequency(n)**	**Percentage**	**Cumulative Frequency**	**Cumulative Percentage**
Above 75%	9	28	25	100
50%-75%	7	36	18	72
25%-50%	6	24	9	36
Below 25%	1	4	3	12
Nil	2	8	2	8

As indicated by Table-5.12, only 28% of the sample secondary schools had more than 75% of the specified chemicals for carrying out biology practical classes. This meant that only 28% of the schools would be able to carry out at least 75% of the chemical reactions that need to be performed at this level. But 36% of the schools had only 50% to 75% of the prescribed chemicals for biology laboratory. While 24% of the sample high schools had just 25% to 50% of the required chemicals, they still wer in a better than position than the 4% of the sample high schools who had less than 25% of the prescribed chemicals. Having less than 25% of the required chemicals meant that these sample schools would not be able to carry out any of the prescribed laboratory work in biology because each of the chemical reactions involved at least two different types of chemicals.

Moreover, considering that 8% of the schools still had no chemicals at all, it could be assumed that these 8% of the sample schools would not be able to perform any biological reactions in their schools. Their students would be totally dependent on theory classes for their knowledge and this was not a good practice for science education which depends heavily on practical work.

5.2.2 Status of Science Laboratories in Higher Secondary Schools:

5.1.4 Physics:

(a) Apparatus and Equipment:-

Table-5.13

Percentages of Sample Higher Secondary Schools having Specified Apparatus and Equipment in Physics Laboratory(N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Cylindrical Body (2.5 cm)	4	27	11	73
2	Rectangular Block (Wooden)	10	67	5	33
3	Vernier Callipers – Adjustable Steel	14	93	1	7
4	Screw Gauge(Least count 0.001cm-Brass)	14	93	1	7
5	Metallic Wire	7	47	8	53
6	Spherical Ball with hook (Brass)	11	73	4	27
7	Clamp Stand	10	67	5	33
8	Resonance Tube (Brass)	4	27	11	73
9	Rubber Pad/Cork-10,12,14,15,17mm bottom diameter	8	53	7	47
10	Thermometer (half and one degree)	9	60	6	40
11	Thermometer (maximum and minimum)	6	40	9	60
12	Travelling Microscope	8	53	7	47
13	Capitally Tube	0	0	15	100
14	Searl’s Apparatus	2	30	13	70
15	Fortin’s Barometer with enough mercury	3	20	12	80
16	Helica’s Spring up to 1 kilogram	3	20	12	80
17	Metre Scale	9	60	6	40
18	Crocodile Jaw (Clips)	1	7	14	93
19	Soldering Reed (35 watt) and Soldering Pad	5	33	10	67
20	Extension Cord	10	67	5	33
21	Ammeter (0-500)MA, (0-1.5)A	15	100	0	0
22	Voltmeter 0-3, 0-5, 0-10	15	100	0	0
23	Meter Bridge (Complete with Jockey)	15	100	0	0
24	Post Office Box	10	67	5	33
25	Potentiometer (4 wire with Jockey)	12	80	3	20
26	Resistance (diff. Ohm), Carbon Resistors	9	60	6	40
27	Sonometer (AC) with slotted weight and anger 0.5 kg	5	33	10	67
28	Tangent Galvanometer (30-0.30-Moving coil type)	15	100	0	0
29	Optical Bench (Steel-1 meter length, double rod with 4 metal)	15	100	0	0
30	Spherometer (0.55mm-Pitch-70-7 Scale)	9	60	6	40

31	Glass Prism (Equilateral 25mm each side)	13	87	2	13
32	Transistor PNP/NPN (AC 187)	7	47	8	53
33	Illuminator	3	20	12	80
34	Multimeter (Analogue)	12	80	3	20

Cont:Table-5.13

Percentages of Sample Higher Secondary Schools having Specified Apparatus and Equipment in Physics Laboratory(N=15)

35	Spirit Level	7	47	8	53
36	Zener Diodes/Diode	4	27	11	73
37	Rheostat (Long)	14	93	1	7
38	Daniel Gell	4	27	11	73
39	Leclanche Cell	5	33	10	67
40	Magnetic Compass	14	93	1	7
41	Concave and Convex Lenses having short focal length	14	93	1	7
42	Drawing Board	12	80	13	20
43	Keys (Plug Keys-Reversing Keys)	10	67	5	33
44	Lead Acid Accumulators/Rechargeable(0-6 volt)	1	7	14	93
45	Step Up/Down Transformer	3	20	12	80
46	Light Emitting Diode (LED)	1	7	14	93
47	L.D.R(light dependent resistor)	0	0	15	100
48	Wrench Box	1	7	14	93
49	Self Adjusting Cutter	5	33	10	67
50	Striper (MT-02)	1	7	14	93
51	Stabilizer (manual)	6	40	9	60
52	Tester Set	9	60	11	40

A s

shown by Table-5.13, only a few items like ammeter, voltmeter, meter bridge, tangent galvanometer and optical bench were found in all 100% of the sample hig schools. The rest of the items were found only in a few of the sample high schools. Some common items like rectangular block, screw gauge, rheostat, magnetic compass and concave and convex lenses were found in more than 90% of the sample high schools. A few more items like clamp stand, thermometer, metre scale, helic's spring, carbon resistors, spherometer, keys and tester set were present in 60% and slightly more than 60% of the sample high schools. Other than the ones mentioned, items like cylindrical body, soldering reed, sonometer, extension cord, diode, lechlanche cell, transformer and self adjusting cutter were present in less than 35% of the sample high schools. Besides this, it was unsettling to see that capillary tube and light dependent resistor were absent in 100% of the schools.

Table-5.14
Availability of Specified Apparatus and Equipment in Physics laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	0	0	15	100
50%-75%	9	60	15	100
25%-50%	4	27	6	40
Below 25%	2	13	2	13
Nil	0	0	0	0

As shown by Table - 5.14, none of the sample higher secondary schools had above 75% of the specified apparatus and equipment in physics. This meant that no school had the required amount of apparatus and equipment to give their student the maximum experience in physics. At the same time,it was also seen that 60% of the schools have only 50% to 75% of the required apparatus and equipment. This is the highest percentage in terms of presence of laboratory equipment and apparatus. This showed that there was a very low level of development especially in the case of physics practical work. The table showed that 27% of the schools had 25% to 50% of the required materials in physics. It is quite obvious that these schools would not be able to perform as well as the previous gruops in physics practical work. It could also be seen that 13% of the schools had below 25% of the required materials. Since they would not be able to perform any of the prescribed expreiments to satisfaction, neither the students nor the teacher would get much opportunity to have depper and more meaningful understanding of the subject. At the same time, as shown by the same table, no sample higher secondary school was found with absolutely no apparatus and equipment in physics. Although the sample schools did not show outstanding results in terms of having the required amount of materials, it was a good sign that they had at least a small amount of apparatus and equipment in physics.

5.2.2.2 Chemistry:

(a) Apparatus and Equipment:-

Table-5.15
Percentages of Sample Higher Secondary Schools having Specified Apparatus and Equipment in Chemistry Laboratory (N=15)

S.L. No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Burette (Torson) – 50ml (Plastic)	14	93	1	7
2	Beakers-500ml, 250ml, 100ml	15	100	0	0
3	Conical flask-250ml,100ml	15	100	0	0
4	Pipette	14	93	1	7
5	Test tube-10ml,20ml,	14	93	1	7
6	Reagent Bottle-1000ml,250ml,500ml	14	93	1	7
7	Funnel(small size glass)	15	100	0	0
8	Glass rod-300x10mm-4mm dia.	14	93	1	7
9	Glass tube-300x5mm	12	80	3	20
10	Volumetric Flask-1000ml,500ml,250ml	12	80	3	20
11	Almirah , wooden 3x6 ft	13	87	2	13
12	Water tanky, syntex-2000lt, export quality	9	60	6	40
13	Burette stand, plastic	13	87	2	13
14	Tripod stand(triangular iron top-9mm)	14	93	1	7
15	Blow pipe, metallic standard	6	40	9	60
16	Cork borer(set of 6 standard-iron)	9	60	6	40
17	Wire gauge(asbestos coated)	14	93	1	7
18	China dish(porcelain dish-70mm dia)	15	100	0	0
19	Mortar and pestle(porcelain)	14	93	1	7
20	Test Tubebrush(good quality)	14	93	1	7
21	Burette Brush(galvanised wire with handle)	5	33	10	67
22	Wash Botle(plastic LD, good quality with nozzle)	11	73	4	27
23	Platinum wire embodied in glass rod	11	73	4	27
24	Hot plate(good quality)	5	33	10	67
25	Hot water bath(good quality with at least 8 holes)	5	33	10	67
26	Spatula(iron)	12	80	3	20
27	Filter paper(wa1tman's)	12	80	3	20
28	Refrigerator	3	20	12	80
29	Electric balance	12	80	3	20
30	Universal indica1tors(solution or paper)	13	87	2	13
31	pH paper	13	87	2	13
32	Measuring cylinder	11	73	4	27
33	10ml,50ml,100mml,500ml	6	40	9	60
34	Long form of periodic table	11	73	4	27
35	Watch glass(big size glass)	11	73	4	27

36	Thermometer 100degrees Celsius and above, plastic	12	80	3	20
37	Overhead projector	3	20	12	80
38	Bunsen burner	13	87	2	13

As shown by the cumulative frequency, less than 100% of the schools had 50% to 75% of the required apparatus and equipment in physics. The table also revealed that 40% of the schools had less than 50% of the required materials; a clear indicator that they would not accomplish much in terms of physics experiment. It was also found that 13% of the schools had less than 25% of the required apparatus and equipment in physics. All these showed that the state was still in its initial stage of development even after more than 10 years of introduction to science stream at the higher secondary level.

As can be seen in Table-5.15 items like beakers, conical flasks, funnel and china dish were found in 100% of the schools. But these were bare essentials and most of the required items for successful practical work were absent in the schools. Items like glass rods, mortar and pestle, wash bottles, reagent bottles etc were found in more than 70% of the sample high schools. But very important items like hot plates, hot water bath, refrigerators and overhead projectors were present in less than 33% of the schools. It was not at all satisfying to see that crucial items like the ones mentioned here were found in such a small percentage.

Table-5.16

Availability of Specified Apparatus and Equipment in Chemistry Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	9	60	15	100
50%-75%	5	33	6	40
25%-50%	1	7	1	7
Below 25%	0	0	0	0
Nil	0	0	0	0

e

fore considering other aspects of a good laboratory in any subject, adequate apparatus and equipment is a must. In the study done on the 15 sample higher secondary schools, as shown by Table-5.16 , only 60% of them had 75% of the minimum requirement made by the MBSE. This in itself showed that only 60%

of the sample higher secondary schools provided a moderate environment for their students to perform their experiments. While 33% of the schools had 50% to 75% of the required apparatus and equipment, 7% of the sample schools still managed with less than 50% of the required materials. This is not a good picture considering that at this level, 30% of the total marks is allotted for practical work.

If one read the cumulative percentage carefully, 40% of the sample schools had less than 75% of the required apparatus and equipment. Another 75% had less than 50% of the minimum requirement made by the MBSE for the equipment of chemistry laboratory. Therefore, it is clear that these sample schools which have been selected from various districts will certainly not be able to provide the necessary equipment for their students. The sad news was that it was not just this level that would suffer but college education as well because these students were future college students. More serious that this was that these very students were the ones who would be teaching science in our future classrooms. A person who was not taught the full import of laboratory work would never be able to teach his students the importance of laboratory work in science education.

(b) Chemicals :-

As seen in table-5.17, the MBSE had prescribed a total of 162 chemicals for a higher secondary school chemistry laboratory. For the sake of convenience, as in other tables, only a few of the items have been mentioned although calculation was done for all the items. Among the items expected to be present in a chemistry laboratory, ammonium ferrous sulphate, ammonium sulphate, hydrochloric acid and oxalic acid were the only ones found in 100% of the sample higher secondary shcools. A few of the items like ammonium nitrate, ammonium oxalate, benzene, cupric carbonate, dimethyl glyoxime, cobalt nitrate, ferric nitrate, iron metal powder, lead dioxide, pottassium nitrate, sodium sulphate and litmus blue etc. were found in 60% or slightly more percentage of the sample higher secondary schools. But worse than this was that there were still a number of items that were found in less than 50% of the schools. Items like ammonium phosphate, acetaldehyde solution, cadmium sulphate, disodium hydrogen phosphate, nessler's reagent, picric acid etc were absent in more than 60% of the sample higher secondary schools. But items like schiff's powder, furural solution were present in less than 10% of the schools whereas sodium citrate was absent in all the sample higher secondary schools. All these indicated that chemistry practical work would certainly not be as vigorous as was expected in the higher secondary section.

Table-5.17
Percentages of Sample Higher Secondary Schools having Specified Chemicals in Chemistry Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Ammonium Molybdate 500g	10	67	5	43
2	Ammonium Carbonate (Purified or AR) 500g	14	93	1	7
3	Ammonium Chloride AR 500g	12	80	3	20
4	Ammonium Sulphate AR 500g	15	100	0	0
5	Ammonium nitrate AR 500g	14	93	1	7
6	Ammonium phosphate 500g	6	40	9	60
7	Ammonium ferrous sulphate AR 500g	13	87	2	13
8	Ammonium ceric nitrate AR 500g	9	60	6	40
9	Ammonium oxalate AR 500g	12	80	3	20
10	Ammonium thiosyanide AR 500g	7	47	8	53
11	Ammonium acetate AR 500g	11	73	4	27
12	Ammonium sulphide 500g	9	60	9	40
13	Aluminium nitrate AR 500g	10	67	5	43
14	Aluminium chloride(hydrated AR) 500g	10	67	5	43
15	Aluminium sulphate AR 500g	9	60	6	40
16	Acetic Acid(glacial AR) 500ml	13	87	2	13
17	Aniline AR 500ml	13	87	2	13
18	Acetone (EL) 500ml	13	87	2	13
19	Acetanilide 500ml	5	33	10	67
20	Acetaldehyde soln.500ml	10	67	5	33
21	Ammonia soln. 500ml	13	87	2	13
22	Bromide water(AR 5x20ml)	10	67	5	33
23	Barium nitrate AR 250g	13	87	2	13
24	Barium chloride AR 250g	14	93	1	7
25	Barium carbonate AR	8	53	7	47
26	Benzoic acid AR 250g	10	67	5	33
27	Benzaldehyde AR 500ml	12	80	3	20
28	Benzene Ar 250g	12	80	3	20
29	Boric acid(crystals AR) 500g	8	53	7	47
30	Benzene crystallizable 500g	4	27	11	73
31	Barium sulphate AR 250g	12	80	3	20
32	Copper sulphate(crystals, soln)500g	12	80	3	20
33	Cupric carbonate 500g	11	73	4	27
34	Cupric chloride AR 500g	12	80	3	20
35	Cupric nitrate 500g	12	80	3	20
36	Calcium chloride dihydride AR 250g	11	73	4	27
37	Calcium sulphate dihydrude AR 250g	10	67	5	33
38	Calcium oxide lumps AR	6	40	9	60
39	Calcium tetrahydride AR	1	7	14	93
40	Calcium carbonate 500g	13	87	2	13
41	Carbon di sulphide AR	5	33	10	67
42	Cadmium sulphate AR	6	40	9	60
43	Cadmium chloride	7	47	8	53
44	Carbon tetrachloride AR	9	60	6	40

45	Copper metal turning	14	93	1	7
46	Chloroform, AR/dry AR	13	87	2	13
47	Cobalt nitrate	11	73	4	27

Cont: Table-5.17
Percentages of Sample Higher Secondary Schools having Specified Chemicals in Chemistry Laboratory (N=15)

48	Charcoal block, activated charcoal AR	8	53	7	47
49	Dimethyl glyoxime AR	12	80	3	20
50	Disodium hydrogen phosphate	7	47	8	53
51	Diethyle ether AR	9	60	6	40
52	2,4 dinitrophenyl hydrazine	11	73	4	27
53	Formaldehyde(diethyl acetal AR)	11	73	4	27
54	Ferrous sulphide	12	80	3	20
55	Ferrous sulphate AR	13	87	2	13
56	Fehlings soln A	15	100	0	0
57	Fehlings soln B	15	100	0	0
58	Ferric chloride	14	93	1	7
59	Ferric nitrate AR	10	67	5	43
60	Ethyl alcohol absolute 99.9% omnis	12	80	3	20
61	Glycerol-glycerine AR	7	47	8	53
62	Hydrogen peroxide 1000ml	10	67	5	33
63	Hydrochloric acid 500lt	15	100	0	0
64	Iron metal powder	8	53	7	47
65	Iodine resublimed	11	73	4	27
66	Lead dioxide or peroxide	11	73	4	27
67	Lead acetae AR	12	80	3	20
68	Lead bromide	10	67	5	33
69	Lead nitrate	12	80	3	20
70	Lead chloride	11	73	4	27
71	Manganous sulphate	10	67	5	33
72	Magnesium sulphate	12	80	3	20
73	Manganese dioxide	10	69	5	31
74	Mercury metal	8	53	7	47
75	Mercuric chloride	5	33	10	67
76	Mercurous nitrate	4	27	11	73
77	Methanol	11	73	4	27
78	Methyl orange	12	80	3	20
79	Manganous chloride	12	80	3	20
80	Mercuric nitrite	4	27	11	73
81	Magnesium chloride	10	67	5	33
82	Nickel chloride	10	67	5	33
83	Nickel sulphate	9	60	6	40
84	1 napthol	13	87	2	13
85	2 napthol	12	80	3	20
86	M nitrobenzene	8	53	7	47
87	Ninhydrine	7	47	8	53
88	Nessler's reagent	12	80	3	20
89	Nittric acid 2.5lts	15	100	0	0
90	Oxalic acid	15	100	0	0
91	Potassium chloride	14	93	1	7
92	Potassium hydroxide	14	93	1	7
93	Potassium iodide	12	80	3	20
94	Potassium dichromide	12	80	3	20
95	Potassium chromate	12	80	3	20
96	Potassium nitrate	10	67	5	33
97	Potassium carbonate	13	87	2	13
98	Potassium ferricyanide	12	80	3	20
99	Potassium sulphocyanide	6	40	9	60
100	Potassium pyroantimonate	2	13	13	87
101	Potassiumferrocyanide	12	80	3	20
102	Potassiumthiocyanide	13	87	2	13

103	Picric acid	5	33	10	67
104	Phenolpthalein	12	80	3	20
105	Pathallic anhydride	2	13	13	87
106	Sodium bicarbonate	13	87	2	13
107	Sodium carbonate	14	93	1	7
108	Sodium sulphide	7	47	8	53
109	Sodium bromide	6	40	9	60
110	Sodium acetate	9	60	6	40

Cont: Table-5.17
Percentages of Sample Higher Secondary Schools having Specified Chemicals in Chemistry Laboratory (N=15)

111	Sodium iodide	6	40	9	60
112	Sodiumnitrate	11	73	4	27
113	Sodium hydroxide	13	87	2	13
114	Sodium nitroprusside	12	80	3	20
115	Sodium chloride	14	93	1	7
116	Sodium sulphate	9	60	6	40
117	Sodium bisulphate	8	53	7	47
118	Sodium thiosulphate	9	60	6	40
119	Sodium metal	11	73	4	27
120	Salicylic acid	5	33	10	67
121	Stannous chloride	9	60	6	40
122	Starch soluble	10	67	5	33
123	Strontium chloride	7	47	8	53
124	Schiff’s powder	1	7	14	93
125	Sulpher powder	9	60	6	40
126	Silver nitrate	13	87	2	13
127	Sulphuric acid	14	93	1	7
128	Sodium sulphite	9	60	6	40
129	Strontium nitrate	8	53	7	47
130	Sodium bisulphate	5	33	10	67
131	Urea	12	80	3	20
132	Universal indicator(soln or paper)	10	67	5	33
133	Xylene	2	30	13	70
134	Zinc sulphate	12	80	13	20
135	Zinc chloride	12	80	3	20
136	Zinc metal	8	53	7	47
137	Zinc carbonate	10	67	5	33
138	Zinc nitrate	10	67	5	33
139	Sodium citrate	0	0	15	100
140	Atomic model set	2	30	13	70
141	Potassium hydrogen sulphide	5	33	10	67
142	Potassium bromide	4	27	11	73
143	Potassium sulpho cyanide	2	30	13	70
144	Nickel carbonate	4	27	11	73
145	Cobalt acetate	3	20	12	80
146	Magnesium acetate	4	27	11	73
147	Magnesium nitrate	9	60	6	40
148	Cobalt chloride	5	33	10	67
149	Sodium cobalt nitrate	3	20	12	80
150	Thiourea	5	33	10	67
151	Litmus blue(solid)	9	60	6	40
152	Diethyl amine	5	33	10	67
153	Potassium permanganate	13	87	2	13
154	pH paper	13	87	2	13
155	Spirit	12	80	3	20
156	Furfural soln.	1	7	14	93
157	Citric acid	3	20	12	80
158	Acetyl chloride	4	27	11	73
159	Benzene sulphanyl chloride	5	33	10	67
160	Phenol	11	73	4	27
161	Lucas reagent	3	20	12	80
162	Tollen’s reagent	11	73	4	27

Chemistry laboratories cannot function without chemicals. So a chemistry laboratory without chemicals is like a classroom without students. It is just like an ordinary room and has no special quality at all. But as indicated by Table-5.18, only 40% of the sample higher secondary schools had above 75% of the minimum requirement made by the MBSE, showing that just 40% of the sample higher secondary schools were able to provide their students with barely standard laboratory work. Since another 40% of the sample higher secondary schools had only 50% to75% of the required chemicals, it was clear that 40% of the sample schools were not be able to provide a wholesome experience to their students. But that 3% of the sample higher secondary schools had less than 50% of the required chemicals showed that even before facing their final examinations, these schools were already at a disadvantage. Since this is the stage where student begin to study their chosen fields, they deserve to be given the best experience that the state can afford. That there were schools that survived with just the bare minimum while Mizoram should be competing with the biggest states in the country was not only detrimental to the development of science education but also to the development of the state considering the vital role science plays in overall development.

Table-5.18
Availability of Specified Chemicals in Chemistry Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	6	40	15	100
50%-75%	6	40	9	60
25%-50%	3	20	3	20
Below 25%	0	0	0	0
Nil	0	0	0	0

In the same table, one could see that 60% of the sample higher secondary schools still had less than 75% of the minimum required chemicals. Since even a 100% would only be a minimum requirement, this was a dismal picture indeed. That 20% of these sample higher secondary schools managd with less than 50% of the required chemicals showed the poor quality of science education that students received even at this crucial stage where students start to devote themselves fully to their chosen fields. With less than 50% of the minimum requirement of chemicals made by the MBSE, it was clear that these schools were not be able to run their laboratories the way they were meant to be run. This clearly was not the ideal atmosphere for the cultivation of interest in science.

5.2.2.3 Biology:

(a) Apparatus and Equipment:-

Table-5.19

Percentages of Sample Higher Secondary Schools having Specified Apparatus and Equipment in Biology Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Incubator	2	13	13	87
2	B.O.D. Bottles	5	34	10	66
3	Burette Stand (Plastic-White)	4	27	11	73
4	Centrifugator	0	0	15	100
5	Bell Jar	4	27	11	73
6	Dryer (Phillips)	1	7	14	93
7	Cotton Wool	12	80	3	20
8	Filter Paper	12	80	3	20
9	Ph Meter	7	47	8	53
10	Gas Connection	0	0	15	100
11	Dissecting Tray (300mm x 250mm x 65mm - Complete white enameled complete with wax- good quality)	9	60	6	40
12	Dissecting Set(Comprising 14 instruments, stainless steel–good quality)	10	67	5	33
13	Compound Microscope (Standard quality eye piece x 10 x 15 (noth mygenian) magnification 100 x 675 x with bx, lock and key - good quality)	14	94	1	84
14	Simple Microscope (Good quality)	9	60	6	40
15	Slides (In box-25 slides size 130mm x 108mm, 38mm standard with index sheet)	13	87	2	13
16	Cover Slips (Circular)	14	94	1	6
17	Petri Dish (100mm x 15mm depth)	13	87	2	13
18	Cancet	3	20	12	80
19	Test Tube Stand (At least 10 holders)	13	87	2	13
20	Crucible	9	60	6	40
21	Droppers – 5ml	14	94	1	6
22	Wide Mouth Bottles – 1000ml	9	60	9	40
23	Maximum & Minimum Thermometer (Dimple Brand)	8	54	7	46
24	Hammer (Small- good quality)	7	47	8	53
25	Rubber Stopper fit for 10, 20, 30mm diameter	9	60	6	40
26	Pipette – 5ml, 10ml, 20ml	11	74	4	26
27	Lab Stand Set	2	13	13	87

28	Test Tubes – 20ml, 50ml (Hard Glass)	**11**	**74**	**4**	**26**
29	Test Tube Holder (Iron – good quality) set	**13**	**87**	**2**	**13**

As could be gathered from table-5.19, only a few of the specified apparatus and equipment like cotton wool, filter paper, petri dish, test tube stand, droppers and test tube hoders were found in more than 80% of the sample higher secondary schools. The rest of the items were present only in small amounts. Apparatus like incubator, cancet and lab stand set, burette stand and dryer were found in less than 30% of the sample higher secondary schools. But the real situation of the biology laboratory was seen in the total absence of items like centrifugator and gas connection were totally absent from the sample higher secondary schools.

Table-5.20

Availability of Specified Apparatus and Equipment in Biology Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	1	7	15	100
50%-75%	9	60	14	93
25%-50%	4	26	5	33
Below 25%	1	7	1	7
Nil	0	0	0	0

Biology comes under life sciences. As such it mostly deals with perishable specimens that need to be handled with care and with good equipment. This is why it demands an adequate supply of good quality apparatus and equipment. However, Table-5.20 here showed that only 7% of the sample higher secondary schools had above 75% of the required apparatus and equipment. This meant that 93% of the sample higher secondary schools operated with less than 75% of the required apparatus and equipment. A huge 60% of the sample higher secondary schools still had only 50% to 75% of the prescribed apparatus and equipment. Another 26% managed with 25% to 50% of the required materials while 7% still had less than 25 % of the required apparatus and equipment. At this pivotal stage where their performance predicts their whole future as far as professions are concerned, it was indeed cause for worry that the laboratories were so ill equipped.

A look at the last column in this table revealed that a staggering 93% of the sample higher secondary schools had less than 75% of the required apparatus and equipment. Considering that students had to face their final examination where 30% of the full marks belong to practical work, it was not proper that schools that did not have the full equipment were still allowed to run. It also showed sheer negligence on the part of teachers, concerned department as well as the government that so many schools were still left with such a poor supply of apparatus and equipment. That 33% of the sample higher secondary schools had less than 50% of the required apparatus and equipment was a clear indicator that the students in different schools had varying levels of opportunities. This meant that there was unequal competition starting from the learning environment itself.

(b) Chemicals :-

Table-5.21
Percentages of Sample Higher Secondary Schools having Specified Chemicals in Biology Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Aceto-Carmine	13	87	2	13
2	Carmine MS	5	34	10	66
3	Iodine Pellets	4	27	11	73
4	Starch- Powder	13	87	2	13
5	Leishman's Stain	12	80	3	20
6	Sucrose Powder	11	74	4	26
7	Glucose Powder	8	54	7	46
8	Benedict's Reagent	14	94	1	6
9	Sulphosalicylic Acid	5	40	10	60

As indicated by Table-5.21, none of the chemicals were present in 100% of the sample higher secondary schools. Items like acetocarmine, starch powder, Leishman's stain and Benedict's Reagent were present in 87%, 87%, 80% and94% respectively in the sample higher secondary schools. But a very opposite picture was seen in the rest of the items like carmine MS, Iodine pellets and sulphosalicylic acid were found in only 40% or less percentage of the sample higher secondary schools.

Table-5.22
Availability of Specified Chemicals in Biology laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	5	33	15	100
50%-75%	8	53	10	67
25%-50%	1	7	2	14
Below 25%	0	0	1	7
Nil	1	7	1	7

Biology practical cannot survive without proper chemicals. That is why this 33% of sample higher secondary schools will be in a far better situation when it comes to providing incentives to their students because they had more than 75% of the required chemicals for performing biological experiments as indicated in Table-5.22. But since 53% of the sample higher secondary schools had only 50% to 75% of the required chemicals, it was clear that a larger portion of these higher secondary schools had no proper means to conduct successful experiments. While it was sad to note that 7% of the sample higher secondary schools had just 25% to 50% of the necessary chemicals, it was alarming to note that 7% of the sample higher secondary schools did not have one item in the list. If this 7% of the sample schools did not show some positive change, it could be predicted that in a few years to come, the percentage of schools that fell in this category would rise and there will surely be a general decline in science education.

The cumulative percentage showed that 67% of the sample higher secondary schools had less than 75% of the required chemicals. In a situation where practical works took up 30% of the mark in the final examination, this surely had to be noted as dangerous. The 14% that had 50% to 75% might be able to survive barely, but the last two groups each taking up 7% of the total sample higher secondary schools had less than 25% and absolutely no chemical in stock would have no opportunity to show their students the beauty of biology. This was sad in a state like this where an interest in life sciences would benefit it so deeply.

(c) `Permanent Slides:-

As shown by Table-5.23, only a small number of the items like T.S of hydra, mitosis cell division, meiosis cell division, and a few of the T.S(transverse section) of plants body were found in 80% or slightly more percentage of the sample higher secondary schools. On the other hand, essential slides like frog's blood smear, unstriated muscles, squamous epithelium, euglena etc were found in only less than 68% of the sample higher secondary schools.

Table-5.23

Percentages of Sample Higher Secondary Schools having Specified Permanent Slides in Biology Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	T.S. of Nerve Cells	10	67	5	33
2	T.S. of Hydra	13	87	2	13
3	Mitosis Cell Division (All Stages)	12	80	3	20
4	Meiosis Cell Division (All Stages)	12	80	3	20
5	Human Blood Smear	10	67	5	33
6	Frog Blood Smear	9	60	6	40
7	Striated Muscles	10	67	5	33
8	Un-striated Muscles	9	60	6	40
9	Cardiac Muscles	9	60	6	40
10	Squamous Epithelium	10	67	5	33
11	T.S. of Dicot Stem	13	87	2	13
12	T.S. of Monocot Stem	13	87	2	13
13	T.S. of Dicot Root	12	80	3	20
14	T.S. of Monocot Root	11	74	4	26
15	Bacteria	12	80	3	20
16	Leaf Stomata	11	74	4	26
17	Sclerenchyma, Parenchyma, Xylems, Phloem, Nostoc, Spirogyra, Oscillatorin, Rhizopus, Anabourn	10	67	5	23
18	Amoeba	12	80	3	20
19	Paramecium	11	74	4	26
20	Euglena	10	67	5	33

Table-5.23 here indicates without a doubt that only 67 % of the sample higher secondary schools had more than 75% of the total permanent slides as prescribed by the MBSE. Another 20% had just 50% to 75% of the required permanent slides. But the worst picture was shown by the 13% from the sample higher secondary schools that had no permanent slides at all. Even if the students from these schools were to be successful in their examinations and thus had a chance to take up science in college, it could be asserted that these students would have the added burden of familiarizing themselves with permanent slides while competing with students who have already been exposed to them. This burden will surely slow them down and could ruin their chances for better participation in college examinations.

Table-5.24
Availability of Specified Permanent Slides in Biology laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	10	67	15	100
50%-75%	3	20	5	33
25%-50%	0	0	2	13
Below 25%	0	0	2	13
Nil	2	13	2	13

(d) Specimens:-

Table-5.25

Availability of Specified Specimens in Biology laboratory in Sample Higher Secondary Schools (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Mosses	8	54	7	46
2	Fern Plant	9	60	6	40
3	Pitcher Plant	7	47	8	53
4	Mildew	6	40	9	60
5	Rust	6	40	9	60
6	Smut	8	54	7	46
7	Potato Blight	11	74	4	26
8	Life Cycle of Silk Moth	11	74	4	26
9	Life Cycle of Frog	12	80	3	20
10	Life Cycle of Honey Bee	8	54	7	46
11	Life Cycle of House Fly	5	34	10	66
12	Life Cycle of Butterfly	8	54	7	46
13	Root Nodules of Legumes	7	47	8	53
14	Liverworts	4	27	11	73
15	Rhizobium	10	67	5	33
16	Fungi (Mushroom)	10	67	5	33
17	Cuscuta	3	20	12	80
18	Hydrilla	11	74	4	26
19	Drocera	1	7	14	93
20	Cactus	9	60	6	40
21	Euphorbia	2	13	13	87
22	Fishes - Shark, Rohu, Anabus, Catla, Common Carp, Grass Carp	7	47	8	53
23	Salamander	3	20	12	80

24	Toad	12	80	3	20
25	Snakes, Lizards, Tortoise, Octopus	7	47	8	53
26	Octopus	6	40	9	60
27	Torpedo	1	7	14	93
28	Pigeon, Parrot, Sparrow	4	27	11	73
29	Rat, Rabbit	3	20	12	80

As seen from Table-5.25, the presence of specimens was also far from satisfactory. Specified specimens like life cycle of frog and toad were the only ones present in 80% of the sample higher secondary schools. Items like fern plant, smut, life cycle of honey bee, life cycle of butterfly, fungi etc. were present only in slightly more than 50% of the sample higher secondary schools. It was disappointing to see liverworts, rhizobium, salamander and pigeon etc. Only in a little more than 20% of the sample higher secondary schools. In fact, specimens of drocera and that of torpedo were found in only 7% of the sample higher secondary schools. All these pointed to the fact that higher secondary schools had poorly equipped biology laboratories even after 15 years of having introduced the subject.

Table-5.26
Availability of Specified Specimens in Biology Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	2	13	15	100
50%-75%	3	20	13	87
25%-50%	5	34	10	67
Below 25%	2	13	5	33
Nil	3	20	3	20

Specimens play an important part in biology because this is the one way that most of them can be displayed in the laboratory. Most of them are perishable and need to be replaced with fresh ones after some years have passed. This is why they need to be maintained as carefully as is possible.

Table-5.26 here shows that only 13% of the sample higher secondary schools had more than 75% of the specified specimens for biology practical class. A large 20% of the sample higher secondary schools had 50% to 75% of the necessary specimens but a larger 34% of these sample higher secondary schools still managed with 25% to 50% of the specified specimens. While 13% of the sample schools had less than 25% of the prescribed specimens, the ones that had no specimens at all made up 20% of the sample higher secondary schools. It was clear that the last 3 groups had no chance to show their students these specimens which were not part of the natural fauna of the land. Therefore, students would have only a vague idea of what these are. This kind of situation was certainly not conducive to a lively interest in science education.

Further study of Table-5.26 with more focus on the the cumulative curve reveals that 87% of the sample higher secondary schools had less than 75% of the selected specimens. Another group that made up 67% of the sample higher secondary schools had less than 50% of the required specimens. But while 33% of the sample higher secondary schools had less than 25% of the required specimens, 20% of the sample higher secondary schools did not have any of the required specimens. The last 20 % was a dangerous number because they might have enough number to pull down the overall quality of science education in the state. All these clearly told a sad story where the victims would not just be the students at the level but the whole educational system, especially the section where science education took up space.

(e) Charts:-

As can be seen from Table-5.27, none of the charts were found in more than 75% of the sample higher secondary schools. Charts showing cell division and plant and animal cells were the only ones present in 74% of the sample higher secondary schools. But charts showing transverse sections of stems, roots, plant kingdom classification, internal structure of heart etc and few other were present in slightly more than 60% of the sample higher secondary schools. But infloroscence, cell organellsand biogeochemical cycles were absent in more than 60% of the sample higher schools.

As evident in Table-5.28, it was apparent that only 34% of the selected charts were present in more than 75% of the sample higher secondary schools. While 27% of the charts could be found in between 50% to 75 % of the selected higher secondary shcools, it was sad to note that 13% of the charts which had been selected to be displayed were not found in any of the sample higher secondary schools. All these show that harts were certainly not a priority in the education of biology at this level.

Table-5.27
Percentages of Sample Higher Secondary Schools having Specified Charts available in Biology Laboratory(N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Cell Division (Mitosis & Meiosis) – Different Stages	11	74	4	26
2	Biogeochemical Cycles (Nitrogen, Co_2, O_2, Phosphorous, Sulphur)	4	27	11	73
3	T.S. of Stem – Dicot and Monocot	10	67	5	33
4	T.S. of Root – Dicot and Monocot	10	67	5	33
5	Secondary Growth of Dicot and Monocot Stem	5	34	10	66
6	Plant Cell and Animal Cell	11	74	4	26
7	Classification of Animal Kingdom	9	60	6	40
8	Classification of Plant Kingdom	10	67	5	33
9	Internal Structure of Heart, Kidney, Lungs and Ovary	10	67	5	33
10	Different Types of Tissue Systems (Animal & Plant)	7	47	8	53
11	Respiratory System, Reproductive System, Circulatory System, Skeletal System, Excretory System and Muscular System of Man	9	60	6	40
12	Cell Organelles (Mitochondria, Nucleus, Chloroplast, Cell Wall, Ribosomes, Endoplasmic Recticulum, Golgi Body, Cilia, Flagella, Centriole, Plasma Membrane, Plastids)	6	40	9	60
13	Life Cycle of Frog, Silk Moth, Mushroom, Fern, Moss, Rhizopus, House Fly, Butterfly	8	54	7	46
14	Infloresence (Different types)	2	13	13	87
15	Digestive System of Human Beings	9	60	6	40
16	Floral Parts (China Rose, Mustard)	8	54	7	46
17	Structure of Human Brain	9	60	6	40
18	Models of DNA	9	60	6	40
19	Models of RNA	8	54	7	46

Table-5.28
Availability of Specified Charts in Biology Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Charts)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	5	34	15	100
50%-75%	4	27	10	66
25%-50%	2	13	6	39
Below 25%	2	13	4	26
Nil	2	13	2	13

(f) Furniture :-

Table-5.29
Percentages of Sample Higher Secondary Schools having Specified furniture in Biology Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Steel Almirah (Big- Godrej)	5	34	10	66
2	Towels	10	67	5	33
3	Wooden Stools (3ft Height)	8	54	7	46
4	White Board	9	60	6	40
5	Practical Tables (6ft x 3 ft – Wooden)	11	74	4	26
6	Table with Chair (Wooden)	11	74	4	26
7	Wooden Almira (6ft x 3ft)	14	94	1	6
8	Buckets (Big-Plastic)	13	87	2	13
9	Plastic Mugs (Big)	13	87	2	13

A critical analysis of Table-5.29 disclosed the fact that the furniture such as wooden almirah, tables with chairs, practical tables, buckets and plastic mugs etc were available in 74% to 94% sample schools. Whereas the steel almirah, white board and wooden stools were only available in 34%, 54% and 60% of sample schools, respectively. Most of the sample schools showed that they had a bare minimum when it came to the furniture. Even schools situated in Aizawl, the capital city, did not have the required amount of good furniture. All these was proof that higher secondary schools were in no way properly equipped with regard to the specified furniture/articles in their biology laboratories.

Table-5.30
Availability of Specified furniture in Biology Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Furniture)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	6	40	15	100
50%-75%	5	33	9	60
25%-50%	3	20	4	27
Below 25%	0	0	1	7
Nil	1	7	1	7

A quick glance at Table-5.30 gives a gestalt view of the availability of specified furniture in sample higher secondary schools. Perusal of data in the referred table revealed that only 40% of the sample schools had more than 75% of the required furniture in their biology laboratories, 33% had 50% to 75% and the remaining 27% had less than 50% of the specified furniture. It was shocking that 7% of the sample higher secondary schools had even less than 25% of the required furniture items and other relevant articles. In the absence of these provisions one easily imagined how much importance was being given by these schools to their practical activities in the teaching of biology.

5.2.3 Status of Science Laboratories in Colleges:

Sadly, the investigator could not repeat the same exercise for college level Science Education because the affiliating body i.e., Mizoram University did not make specifications as was done by the MBSE for school education. According to the University Ordinance[10], the University had made a number of stipulations for a college to be affiliated to it, in cluding those offering science as a subject. However, It was silent with regards to the various equipment needed to have a science laboratory that would adequately provide the needs of its students.

5.3 Practical Activities For the Teaching of Science at Different Levels of Education.

A major area of concern is the degeneration of rigour in experimental work in secondary and higher secondary schools. Yet science is a subject whose teaching cannot be completed by mere classroom lecture. It needs a dedicated effort that combines classroom teaching with demonstration and laboratory work that can stimulate the brain of students and encourage them to take bigger steps in the field of science. The checklist which had previously been circulated to sample secondary schools and higher secondary schools had revealed that schools were differently endowed when it came to practical facilities. But it is a known fact that even the most well equipped schools tend

[10] **OB – 6 ON THE AFFILIATION OF COLLEGES** Under Section 26 (1)(n) of the MZU Act,2000 (read with Clause (7) of Statute 31)

to give only cosmetic importance to laboratory work. This has resulted in schools producing students with much theoretical knowledge but very little practical knowledge about scientific phenomena.

Before embarking on an endeavour to find out the amount of time schools give to practical work, the investigator found it necessary to pay a visit to the SCERT in order to find out whether they had given any advice or a master plan for the weekly routine of science in schools. Unexpectedly, the investigator was told that no such plan was made and that schools had to make their own time tables based on their own priorities.

5.3.1 Status of Practical Activities in Sample High Schools:

The following tables show the number of practical activities done by schools on a weekly basis besides a few other information:

Table-5.31shows that out of 25 secondary schools, 20 schools had laboratory for science practical work. The table also showed that none of the schools had a separate laboratory for physics, chemistry and biology. This could be because the MBSE has not been very strict in laying down the conditions for high schools and only stated separate rooms as desired and not as a condition for the school to be affiliated to it.

Table-5.31
Presence of Science Laboratories in Sample High Schools

Whether school has a Science laboratory				**Separate laboratory for physics, chemistry and biology**			
YES		**NO**		**YES**		**NO**	
N	%	N	%	N	%	N	%
20	80	5	20	0	0	25	100

Table-5.32
Number of Practical Classes held each week in Sample Higher SecondarySchools

No Practical Class		**One Practical Class Per Week**		**Two Practical Classes Per Week**		**Three Practical Classes Per Week**		**Four Practical Classes Per Week**	
N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**

14	56	8	32	1	4	1	4	1	4

An incriminating fact that emerged out of the checklist was that out of the 25 schools, only 11(44%) of them could hold practical classes on a weekly basis. Among these, 8(32%) of them could do so just once a week. As shown by the Table-5.32, only 1(4%) school could have 4 practical classes in a week and another could have it 3 times a week. The rest 14 of them could not do so even for a single class in a week. Among the schools that could devote their time to practical work on a weekly basis, And though this fact was not reflected in the present table, informal interaction with the science teachers revealed that most of these schools had their practical classes a few weeks before their external examinations so that students would not be so lost when their examination came. There were also a few schools that did not do any practical work at all. This was not a healthy result even in the absence of a clearly laid down timetable by the SCERT. Science education, unlike most other subjects, if not complimented by practical work becomes a heavy set of an abstract world coded in long texts and difficult language. More than any other subject, it needs a healthy balance of classroom lecture and laboratory work. Therefore the absence of a healthy balance between theory and practical was surely a negative picture of the status of science educaiton in the state.

Since the investigator had the opportunity to have face to face interaction with the science teachers, she took advantage to inquire about the supply of materials since another checklist had revealed a poor collection of laboratory apparatus in most of the schools. All the teachers and laboratory assistants complained that supply of science kits were irregular and that often, they had to make their requests to the Science Promotion Wing in order to get fresh supplies. Especially for the schools outside the city, another problem was that they had to go to the wing to fetch their supplies and this added to their yearly expenditures because no provision for that was made in the financial grants allotted to the schools.

Another fact that emerged out of the checklist was that there was still some disparity in the distribution of science teachers among different schools.

While there were schools with more than 100 students taken care of by 2 or 3 science teachers, there were those that had the same number of students or more taken care of by a single science teacher. The MBSE clearly laid down that all the teachers of a High School shall be graduates with a Professionals Degree from a recognised University and at least two of them should be science graduates, one being capable of teaching either Mathematics or both. This meant that Mizoram, even after 24 years of becoming a full fledged state, still had high schools that operated in violation of the State Board of School Education.

Table-5.33
Student teacher ratio in sample high schools

Student teacher ratio	**Class VIII**		**ClassIX**		**Class X**	
	N	%	N	%	N	%
1:10 to 1:25	8/25	32	7/25	28	14/25	56
1:26 ti 1:40	5/25	20	10/25	40	5/25	20
1:41 to 1:55	4/25	16	3/25	12	4/25	16
1:56 to 1:70	4/25	16	1/25	4	1/25	4
1:71 and above	4/25	16	4/25	16	1/25	4

As seen in Table-5.33, the student teacher ratio in many of the sample high schools were not at all safe. At the Class VIII level, taking for granted that a ratio of upto 1:40 is within the desirable range, 52% of the sample schools fell within this range, but the rest 48% still survived on the undesirable side and in fact, 16% of the schools had a ratio of 1:70 which meant that a teacher took care of 70 students everyday. Class IX profile was slightly better oweing to the fact that the number of students had come down. In this case, it was also enough reason to feel alarmed because the fall in the number of students could be due to drop out or stagnation, both of which are a huge waste of human and financial energy. ClassX stage had the best profile because 76% of the sample schools fell within the desirable range. But in consideration of the crucial importance played by the high school stage, it was a wonder that so many schools were allowed to function with such unhealthy student teacher ratio.

The overall student teacher ratio also showed that there was a huge difference between Class VIII and Class X. While there was a ratio of 1:42 at the Class VIII level, which bordered on the undesirable, the ratio of 1:25 at the Class X level was well within thte desirable range. This disparity between classes is something that needs to be carefully looked into because no stage is more important than the other from the educational point of view.

5.3.2 Status of Practical Activities in Sample Higher Secondary Schools

The following tables show the status of practical activities in the sample higher secondary schools:

Table-5.34 indicates the status of laboratories in 15 sample higher secondary schools that were chosen from different parts of the state covering government, deficit and privately owned higher secondary schools. As shown in the table, 100% of the schools had a separate room for physics, chemistry and biology practical work. It may be noted that higher secondary stage is the stage where diversification of disciplines start. This could be the reason for the measure of independence each discipline seems to have from another discipline.

Table-5.34
Status of Science Laboratories in Sample Higher secondary Schools

Whether school has a Science laboratory				Separate laboratory for physics, chemistry and biology			
Yes		No		Yes		No	
N	%	N	%	N	%	N	%
15	100	0	0	15	100	0	0

Table-5.35
Status of Practical Classes Per Week in Sample Higher Secondary Schools

Less than 4 practical classes per week		4-6 Practical Class Per Week		7-9 Practical Classes Per Week		10-12 Practical Classes Per Week	
N	%	N	%	N	%	N	%
3	20	7	46	4	27	1	7

As evident in Table-5.35, except for 2(13%) schools that could perform practical work only once and twice in a week respectively, most of the schools

(80%) could have practical classes at least 4 times in a week. This is a clear indicator that practical classes are taken more seriously at this stage. 1 school (7%) could even hold practical classes 12 times in a week. If this was the case, one could infer that when it came to practical works, higher secondary schools were quite active, especially in comparison to high schools.

As earlier stated in the high school section, the investigator could also glean a few pertinent facts that could not be reflected in the table. It was clearly stated by the teachers concerned themselves that even in this stage, practical work could not be given the priority it deserved due to lack of facilities. There were only a few experiments that students could perform on an individual basis. The rest had to be shared between 2 or more students and there were even some experiments where students had to be satisfied by a single demonstration.

Thus, higher secondary schools certainly performed better in terms of practical works and they showed a better status in comparison to high schools. But given the fact that higher secondary stage was the level where diversification of subjects into different streams began, this was only to be expected. In fact, the investigator found the difference less than desirable. But for higher secondary schools to perform better there has to be bigger input for teachers as well as laboratory equipment.

Table-5.36

Student Teacher Ratio in Sample Higher Secondary Schools

Student teacher ratio	**Physics**		**Chemistry**		**Biology**	
	N	%	N	%	N	%
1:1 to 1:9	3/15	20	3/15	20	3/15	20
1:10 to 1:25	7/15	47	7/15	47	10/15	67
1:26 to 1:40	5/15	33	5/15	33	2/15	13

The student teacher ratio of ClassXII level, as shown by Table-5.2.2.3 strongly indicated that the student teacher ratio in the sample higher secondary schools fell below the national average of 1:42(UNICEF 2004). But this was still much higher than the ideal situation of 1:20 as calculated by Western educationists. However, in the case of biology, 67% of the sample secondary schools were within the desired range of 1:25. Only 13% of the sample higher secondary schools were outside the desirable ratio. However, in the subjects of physics and chemistry, the student teacher ratio still remained at 1:33, when this study was undertaken.

Table-5.37
Overall student teacher ratio in higher secondary schools

Student teacher ratio	**Physics**	**Chemistry**	**Biology**
	1:20	1:20	1:16

The overall student teacher ratio, as shown by Table-5.37 clearly showed that the sample higher secondary schools had good student teacher ratio. It fell much below the national average. This meant that the teachers were able to devote more time to students. Infact, when compared to states like Uttar Pradesh and Bihar where the pupil teacher ratio is 1:83(UNICEF), this was good situation, especially for practical classes.

5.2.3 Status of Practical Activities in Colleges

The status of practical classes in colleges offering science education may be highlighted with the help of the following tables:

Table-5.38
Status of Science Laboratories in colleges offering science

Whether college has a Science laboratory				**Separate laboratory for physics, chemistry and biology**			
Yes		**No**		**Yes**		**No**	
N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
6	100	0	0	6	100	0	0

A look table-5.38 indicates that science education at the college level had a sharply different characteristic when compared to school education including higher secondary school education. All the colleges had a separate laboratory for each subject. However, as seen by the researcher, most of them were not in the proper form as was expected of a college teaching science. In fact, many of the college laboratories were not pucca buildings and did not have the ideal equipment so as to foster a good understanding of scientific phenomena.

Table-5.39
Status of Practical Classes Per Week in colleges offering science

Less than 4 practical classes per week		4-6 Practical Class Per Week		7-9 Practical Classes Per Week		10-12 Practical Classes Per Week	
N	%	N	%	N	%	N	%
0	0	5	83%	0	0	1	17

As revealed in Table-5.39, although 83% of the colleges could hold more than four practical classes in a week, it was still shown that 17% of them could have more than ten practical classes in a week. It was obvious that there still existed some disparity between young colleges and the older ones located in the capital. The positive side of this is that, unlike higher secondary and secondary schools, there were no colleges that could not have at least one practical classes in a week. But since the data was a combinatin of honours and general courses, the investigator still felt that there was room for much improvement especially considering that science is a subject almost wholly centred on practical activities.

Table-5.40
Status of Laboratory Staff in colleges offering science

Presence of Laboratory Assistant											
In 5 subjects		In 4 subjects		In3 subjects		In 2 subjects		In 1 subject		nil	
N	%	N	%	N	%	N	%	N	%	N	%
0	0	1	17	0	0	0	0	2	33	3	50

Laboratories cannot function properly without the laboratory assistant for each subject who makes arrangement for scientific experiments and keeps a record of the various apparatus and equipment that the laboratory needs. When a laboratory does not have a proper laboratory assistant, all these works are left unattended and the laboratory cannot function like a complete body. The added problem is that the teachers themselves have to assist the assistant in turn. This has adverse effect on the quality of scientific experiment as much time is often wasted in making arrangements for each experiment.

A look at Table-5.40 clearly indicates that 50% of the colleges teaching science still functioned with no laboratory assistant in any of the subjects at the time the investigation was done. Only 17% of the colleges had a laboratory assistant for 4 subjects.

Table-5.41

Status of Laboratory Staff in colleges offering science

Presence of Laboratory Attendant											
In 5 subjects		**In 4 subjects**		**In 3 subjects**		**In 2 subjects**		**In 1 subject**		**nil**	
N	%	N	%	N	%	N	%	N	%	N	%
3	50	0	0	0	0	2	33	1	17	0	0

As revealed in Table-5.41, the status of college laboratories in terms of presense of laboratory attendants was also weak. The laboratory attendant or the laboratory bearer is the one who actually gets the laboratory ready for the day. He or she has to see that there is sufficient equipment and also ensures proper planning for each experiment. But as seen in the table, although there was no college that did not have at least one in place, only 50% of the colleges had one laboratory attendant for each subject and 17% of the colleges still had to function with just one laboratory attendant.

Colleges are under the care of Higher and Technical Education in Mizoram in terms of financial aid. Except for Pachhunga University College which is a constituent college of Mizoram University, the main financial allocations are made through this body although there are special funds that come directly from the University Grants Commission. As such this Directorate implements various programmes aimed at improving higher education. One such duty is to give information with regards to the eligibility of a college to be provincialised. One such stipulation is that the college should have adequate qualified teaching staff and non-teaching staff to be appointed on a regular basis. Being the affiliating body, Mizoram University has also clearly asserted the need for adequate teaching staff if a college is to be affiliated to it. In fact, the University ordinance has clearly spelled the minimum staffing requirement as at least five teachers for an honours course in science and for teachers for a three year degree course in general science. During the time this study was conducted, only the two colleges located in the capital city of Mizoram and Lunglei College could meet the minimum requirement laid down by the affiliating university. But so far, most of the colleges still seem to be in need of part time teachers as well as teachers on contract basis in order to fulfill the minimum requirement. As there is no security in these kinds of posts, there is always a threat that the college may suddenly be left with inadequate teachers since the temporary teachers are free to look for other means of employment if the government cannot guarantee a permanent position for them.

Table-5.42
Student teacher ratio in colleges

Student teacher ratio	**1st year**		**2nd year**		**3rd year**	
	N	%	N	%	N	%
1:0 to 1:5	4/6	67	5/6	83	5/6	83
1:6 to 1:10	1/6	17	1/6	17	1/6	17
1:11 to1:15	-	-	-	-	-	-
1:16 to 1:20	1/6	16	-	-	-	-

As per new regulations of the UGC, the student teacher ratio should be one for every 25 students at the undergraduate level. As shown by the Table-5.42, the first, second and third year students showed a ratio of less than 1:10, with only the first year batch surpassing the norm of 1:10. Although this looked like a good profile, it could not really be accepted as good when studied from the economic point of view. Some colleges even had almost the same number of students and teachers. With the infrastructure needed for the setting of laboratories, its equipment and the human resources need, a ratio of less than 1: 20 meant that science education certainly gave small returns in consideration of the labour given to it.

Table-5.43
Overall student teacher ratio in college

Student teacher ratio	1st year	2nd year	3rd year
	1:6	1:2	1:2

As would be expected, the student teacher ratio at the college level was barely 1:6, as seen in Table-5.43. According to the ordinance maintained by the affiliating body,under Section 26 (1) of the MZU Act 2000, colleges that had a three year degree course in general science need to have at least four teachers for each subject and five teachers for each subject in th ehonours course. This meant that during the time this study was done, science education was still a very expensive endeavour with only a handful of students under the care of four or five teachers, depending on the type of the course. Such a situation was not at all desired given the need for the state to produce more science graduates to take care of science education at the school level and to increase enrolment at the post graduate level.

5.4 Critical Analysis of time table at various levels of Science Education

Time table, the main document that acts as a guideline for educational institutions world over is one of the most important element when studying the status of educational systems. In the present study, time tables of sample schools from HSLC, HSSLC and college were taken to analyse the amount of time devoted to theory and practical education.

In Mizoram, the basic knowledge of Science, including Physics, Chemistry, Biology and Mathematics is compulsory for every student till 10th grade.

After class 10th, a student may choose any of the available streams. In class 11th and 12th, those who take science, learn the basics of Applied Physics, Applied Chemistry, Plant and Animal Biology and/or Higher Math. After completion of Class 12, one can either take the conventional way i.e. do courses such as B.Sc and M.Sc (or can opt for a professional career such as B.Tech and MBBS outside the state).

Based on the subjects offered, a curriculum is prepared and the time table is designed for each class in order to realize the goals of the curriculum. Although the MBSE has not prepared a model time table for schools at this level, nor has the affiliating University set the amount of time to be devoted to each subject at various levels, the investigator considered it important to thoroughly study the distribution of different subjects and analyse whether the real needs of students are met. The pertinent information with regards to the weekly distribution of classes at different levels of education from secondary to college level for the year 2010 has been shown in the following tables:

5.4.1 Analysis of Time Tables of High Schools:

A look at Table-5.44 revealed that during the time the investigation was done, it was found through the school time tables that the sample high schools seemed to take theory classes more seriously than practical classes. As far as theory classes were concerned, 4% of the sample high schools could give 12 theory classes in a week. A majority of 75% of the sample high schools could give 9 science theory classes in a week. Only 20% of the sample high schools could give a minimum 5 theory classes in a week. All these facts showed that theory classes were not neglected in the sample high schools.

Table-5.44

Allotment of Theory and Practical Classes in Class-X in Time Table in Sample High Secondary Schools (N=25)

No.of Classes Per Week	Theory		Practical	
	N	%	N	%
12	1	4	-	
9	3	75	-	
8	2	8	-	
7	14	56	-	
6	5	20	-	
2	-		1	4

As far as the practical classes were concerned, only 4% of the sample high schools could have 2 practical classes in a week. The rest 96% of the sample high schools did not make allotment for practical classes in their time table.

5.4.2 Analysis of Time Tables of Higher Secondary Schools

Table No-5.45
Allotment of Theory and Practical Classes in Class-XI in Time Table in Sample Higher Secondary Schools (N=15)

No.of Classes Per Week	Theory Subject			Practical			Remarks
	Physics	Chemistry	Biology	Physics	Chemistry	Biology	
8 & Above	3(20%)	2(13%)	3(20%)	-	-	-	20% of the sample schools allotted 4 classes for practical classes in a week without specifying the subject.
7	4(27%)	2(13%)	2(13%)	-	-	-	
6	6(40%)	3(20%)	3(20%)	-	-	-	
5	5(33%)	6(40%)	5(33%)	-	-	-	
7	4(27%)	2(13%)	2(13%)	-	-	-	
6	6(40%)	3(20%)	3(20%)	-	-	-	
5	5(33%)	6(40%)	5(33%)	-	-	-	
4	3(20%)	2(13%)	2(13%)	-	-	-	
2	-	-	-	7(47%)	7(47%)	7(47%)	
Nil							

As revealed in Table-5.45, the XI level science was still much dominated by theory classes. At the time the investigation was done, the sample schools showed the following results based on their time table:

- For physics, 20% of the sample higher secondary schools could have 8 or more theory classes in a week. It was seen that 40% of the sample higher secondary schools could have 6 theory classes in a week. But the data clearly showed that 20% of the sample higher secondary schools could have only 4 classes in a week.
- For chemistry classes, it was seen that 13% of the sample higher secondary schools could have 8 or more theory classes in a week. At the same time, it was also seen that another 13% of the sample higher secondary schools could have only 4 theory classes in a week.
- In biology, the sample higher secondary schools exhibited almost the same trend that was found in other science subjects. While 20% of the sample higher secondary schools could have 8 or more theory classes in a week, 13% of the

sample higher secondary schools could not have more than 4 theory classes in a week.

- As far as practical classes were concerned, 47% of the sample higher secondary schools showed that they could have 2 practical classes in a week. At the same time, it was also seen that 20% of the sample higher secondary schools set aside 4 classes for practical classes in a week without specifying the subject whose practical work would be taken up. The rest of the sample higher secondary schools did not show any place for practical work as shown by the time table.

Table-5.46
Allotment of Theory and Practical Classes in Class-XII in Time Table in Sample Higher Secondary Schools (N=15)

No.of Classes Per Week	Theory Subject			Practical		
	Physics	Chemistry	Biology	Physics	Chemistry	Biology
8 & Above	3 (20%)	3(20%)	2(13%)	-	-	-
7	4(27%)	3(20%)	2(13%)	-	-	-
6	2(13%)	3(20%)	4(27%)	-	-	-
5	4(27%)	4(27%)	4(27%)	-	-	-
4	2(13%)	2(13%)	3(20%)	-	-	1(6%)
2	-	-	-	8(53%)	8(53%)	7(47%)
Nil				7(47%)	7(47%)	7(47%)

A look at Table-5.46 showed clearly that at the class XII level, theory classes still occupied a much bigger place in the time table when compared with practical work. A look at each subject revealed the following facts:

- For physics, only 20% of the sample higher secondary schools had 3 theory classes in a week. It was also seen that 13% each, of the sample higher secondary schools could have 6 and 4 theory classes in a week. At the same time the data also showed that 27% each, of the sample higher secondary schools could have 7 and 5 theory classes in a week.

- For the practical classes, it was shown that out of the sample higher secondary schools, only 53% of them could have at least 2 practical classes in a week. The rest 53% did not show any allotment for physics in their time table.
- In chemistry, the sample higher secondary schools showed that 20% each, had 8 or more, 7 and 6 theory classes respectively, in a week. It was also seen that 27% of the sample higher secondary schools could have 5 theory classes in a week. But 13% of the sample higher secondary schools could have only 4 theory classes in a week.
- For the practical classes, it was seen that 53% of the sample higher secondary schools could give 2 practical classes in a week, But even here, the rest 47% of the sample higher secondary schools could not give any practical work as indicated by their time table.
- In biology, 13% each, of the sample higher secondary schools could give 8 or more and 7 theory classes in a week. It was also seen that 23% each, of the sample higher secondary schools could have 5 and 6 practical classes in a week. But even in this subject, 20% of the sample higher secondary schools still showed that they could not give more than 4 theory classes in a week.
- A look at the practical classes for biology revealed that unlike the other sciences, 6% of the sample higher secondary schools could give 4 practical classes in a week and this was because in these schools Biology was divided into Zoology and Botany and practical classes were thus given separately. The data also showed that 47% of the sample higher secondary schools could have 2 practical classes in a week but sadly, an equal percentage showed that they could not have any practical classes as was indicated by their time table.

5.4.3 Analysis of Time Tables of Colleges:

5.4.3.1 Time Tables of Colleges: A Macro Analysis:

As indicated by Table-5.47, during the time this investigation was done, the overall distribution of theory and practical class in colleges teaching science was not good. Practical classes took very little space by looking at the time table. A look at the honours course reveal that from the first to the third year, theory classes took an average of 72% of the total classes in a week.

Although science is a subject based on practical work, the colleges of Mizoram teaching science still devoted themselves more on theory classes rather than to practical classes. Science Education plays an important role in creating scientific temper and generating wealth through science-based technologies. But its role is accomplished only when it is accompanied by well developed practical work. Therefore, the fact that there still existed such a wide gap between theory and practical work was a clear indicator that the state was still very much in lack of a proper science education system even at the college level.

Table-5.47
Weightage Given to Theory and Practical Classes in General and Honours Courses at College Level

Year	**Honours**		**General**	
	Weightage to Theory Classes (%)	**Practical %**	**Weightage to Theory Classes (%)**	**Practical(%)**
1st Year	72	28	75	25
2nd Year	74	26	71	29
3rd Year	71	29	75	25

Unexpectedly, general course time table did not vary much from honours course time table, as indicated by Table-5.47, 73% of the entire classes in a week was taken up by theory classes. This showed that practical classes were given only a minor importance in general course.

5.4.3.2 Time Tables of Colleges: A Micro Analysis:

Developed countries in spite of being very successful in science and technology keep on working at making science education more attractive for young people so that their citizens maintain interest and curiosity about the world they live in, and also to meet the future challenges in health, energy, global warming and many other critical areas. The macro analysis of the college time tables had revealed that throughout the three years of under-graduate science education, practical education had taken up less than 30% in the time tables. The following is a micro analysis of time tables of the colleges offering science subject which indicates the real situation of science education at the college level during the time this study was done.

Table-5.48

Time Table for 1st Year B.Sc(Honours)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemisty		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	6	4	6	4	6	4	6	4	6	4	NA	NA	**30 (60)**	**20 (40)**
Zirtiri Residential Science College	6	2	6	2	6	2	6	2	NA	NA	6	2	**30 (75)**	**10 (25)**
Lunglei Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Champhai Gov't. College	10	2	10	2	10	2	NA	NA	NA	NA	NA	NA	**30 (83)**	**6 (17)**
Kolasib Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Serchhip Gov't. College	5	2	5	2	5	2	5	2	NA	NA	NA	NA	**20 (71)**	**8 (29)**

**No honours course in Champhai Gov't. College*

As shown by Table-5.48, except for Pachhunga University College, which devoted 60% to theory classes and 40% to practical classes, all the colleges that offered science subject gave less than 30% of the classes for practical works. The least time devoted to practical work was by Champhai Gov't. College which only gave 17% of the classes to practical works as shown by their time table. Only Pachhunga University College and Zirtiri Residential Science College offered honours courses in 5 subjects. The rest of the colleges offered honours courses for 4 subjects except for Champhai Gov't College which did not have affiliation for honours course in zoology.

Table-5.49

Time Table for 1st Year B.Sc(General)

Name of the college	Physis		Chemisy		Botany		Zoology		Geology		Biochemistry		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	6	2	6	2	6	2	6	2	3	2	NA	NA	**27 (73)**	**10 (27)**
Zirtiri Residential Science College	7	2	6	2	6	2	7	2	NA	NA	6	2	**32 (76)**	**10 (24)**
Lunglei Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Champhai Gov't.	7	2	7	2	7	2	7	2	NA	NA	NA	NA	**28**	**8**

College													**(78)**	**(22)**
Kolasib Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Serchhip Gov't. College	5	2	5	2	5	2	5	2	NA	NA	NA	NA	**20 (71)**	**8 (29)**

A look at the Table-5.49 clearly showed that there was not much difference in terms of class distribution when comparing honours and general courses. The table showed that 100% of the colleges offering science courses devoted more than 70% of their time to theory classes as shown by their time table. None of the colleges gave more than 30% to practical work.

Table-5.50
Time Table for 2nd Year B.Sc(Honours)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemistry		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	5	2	5	2	5	2	5	2	5	2	NA	NA	**25 (71)**	**10 (29)**
Zirtiri Residential Science College	5	2	5	2	5	2	5	2	NA	NA	5	2	**25 (71)**	**10 (29)**
Lunglei Gov't. College	5	2	5	2	5	2	5	2	NA	NA	NA	NA	**20 (71)**	**8 (29)**
Champhai Gov't. College	10	2	10	2	10	2	10	2	NA	NA	NA	NA	**40 (83)**	**8 (17)**
Kolasib Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Serchhip Gov't. College	6	2	5	2	5	2	5	2	NA	NA	NA	NA	**21 (75)**	**8 (25)**

An analysis of theory and practical classes in 2nd year B.Sc honours course in Table-5.50 was seen here. Not surprisingly, a similar pattern previously witnessed in the 1st year B.Sc time table was seen . The maximum time is devoted to theory classes in all the colleges involved. The classes devoted to theory classes ranged from 71% to 83% of the total classes in a week. On the other hand, the classes devoted to practical works ranged between 17% to 29% of the total number of classes in a week as shown by their time tables.

Table-5.51
Time Table for 2nd Year B.Sc(General)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemistry		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	7	2	7	2	7	2	7	2	3	2	NA	NA	31 (76)	10 (24)
Zirtiri Residential Science College	9	4	9	2	9	2	9	2	NA	NA	9	2	45 (82)	10 (18)
Lunglei Gov't. College	8	2	8	2	8	2	8	2	NA	NA	NA	NA	32 (80)	8 (20)
Champhai Gov't. College	9	2	8	2	8	2	9	2	NA	NA	NA	NA	34 (81)	8 (19)
Kolasib Gov't. College	9	2	6	2	7	2	8	2	NA	NA	NA	NA	30 (79)	8 (21)
Serchhip Gov't. College	5	2	5	2	5	2	5	2	NA	NA	NA	NA	20 (71)	8 (29)

Table-5.51 shows the distribution of practical and theory classes in 2nd year B.Sc. Here again, there was not much variation between colleges and not much difference was found when compared with class distribution for honours course. The data showed that 50% of the colleges that offered science course devoted more than 80% of the total number of classes to theory classes. Much less time was given to practical works. Serchhip Gov't college was the college that gave maximum priority to practical work by setting aside 29% of the total number of clases to practical work.

Table-5.52
Time Table for 3rd Year B.Sc (Hons)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemistry		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	8	4	8	4	8	4	8	4	3	4	NA	NA	35 (64)	20 (36)
Zirtiri Residential Science College	9	2	9	2	9	2	9	2	NA	NA	9	2	45 (82)	10 (18)
Lunglei Gov't. College	9	2	9	2	9	2	9	2	NA	NA	NA	NA	36 (82)	8 (18)
Champhai Gov't. College	9	2	9	2	9	2	9	2	NA	NA	NA	NA	36 (82)	8 (18)
Kolasib Gov't. College	10	2	10	2	10	2	10	2	NA	NA	NA	NA	40 (83)	8 (27)
Serchhip Gov't. College	3	2	5	2	4	2	4	2	NA	NA	NA	NA	20 (71)	8 (29)

As indicated by Table-5.52, three of the colleges, namely Zirtiri Residential Science College, Lunglei Gov't. College and Champhai Gov't. College showed dismal performance in terms of class distribution between theory and practical classes by giving only 18% of the total classes to practical works. Pachhunga University College showed the best profile by devoting 36% of the total classes to practical work. Serchhip Gov't. College also did quite well in comparison to the other colleges by giving 29% of the total classes to practical work. However, considering that it was the final stage of honours course in question, it was disappointing to find that not much difference was found between the theory and laboratory work.

Table-5.53
Time Table for 3rd Year B.Sc (General)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemisty		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	5	2	4	2	6	2	5	2	3	2	NA	NA	**23 (70)**	**10 (30)**
Zirtiri Residential Science College	8	2	7	2	5	2	8	2	NA	NA	5	2	**32 (76)**	**10 (24)**
Lunglei Gov't. College	5	2	7	2	5	2	6	2	NA	NA	NA	NA	**23 (74)**	**8 (26)**
Champhai Gov't. College	9	2	8	2	6	2	9	2	NA	NA	NA	NA	**32 (80)**	**8 (20)**
Kolasib Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Serchhip Gov't. College	4	2	5	2	5	2	5	2	NA	NA	NA	NA	**19 (70)**	**8 (30)**

Table-5.53 highlights the distribution of theory and practical work for general course in the 3rd year B.Sc. Although this was a general course, it was refreshing to find that two of the colleges namely Pachhunga University College and Serchhip Gov't. College gave 30% of the total number of classes to practical work. The rest of the colleges gave not more than 26% of the total classes to practical work. Besides this, not much difference was found between honours and general courses.

5.5 Conclusion:

Science cannot be fully understood and appreciated without a thorough understanding of scientific principles which can only happen when it is done practically. Although practical work may be a bit more expensive than theory classes, it is an endeavour worth investing in because it is the only way with which students will be able to understand the true importance of science in their everyday life. As shown by the time tables of the six colleges offering science education, there was a huge gap between theory and practical classes. This was not a healthy picture as it indicated that science education in Mizoram was still concentrating on the theory part rather than on the practical part. If the state truly desires to bring up citizens that would be in a position to take the state and the country to further progress in technological development, than a strong reconsideration of its science syllabus is a must.

As shown by the checklist which was meant to find out information with regards to the status of practical classes, it was clear that secondary schools and higher secondary schools are far from satisfactory in maintaining adequate laboratories for science education. This could be due to lack of interest in the practical side of science education. But most of these schools reported that they did not receive the required amount of equipment from Science Promotion Wing. The little amount of apparatus and equipment they had were those bought by the schools. This, as the investigator found out, was the main reason behind the wide disparity that existed among schools in the urban area and in the rural areas. While most of the schools in the urban areas had students with parents who could help out in the equipment of school laboratories with good equipment, those in the rural areas did not have the support of their parents who were mostly daily wagers. As such, equal distribution of laboratory facilities was not found. On the other hand, since all schools were expected to receive equipment from the Science Promotion Wing, it was disheartening to find certain schools that did not even have the bare minimum for their science laboratories. In fact, many of the so called laboratories were store rooms converted as makeshift laboratories. Hardly any school could meet the requirement made by the MBSE. However, as their rules and guidelines had the accompanying foot note that in special cases, relaxation will be made, these schools still exist. The investigator found that many of the schools just managed to survive because of the last provision On the other hand, if these schools were closed, there would be no other alternative for the students except private schools. Since private schools are expensive, most parents, especially in the rural areas will not be able to send their children for school. The result will be total chaos. But if the present situation is allowed to continue, the serious fall in quality will adversely affect the other levels of education as well as the society at large. The investigator, upon finding this result also concluded that this could be the reason for the gradual decline of practical work and experimentation at secondary schools and higher secondary schools.

It was sad to find even colleges falling so far behind expectations. As could be interpreted from the above analysis, if one may mark Aizawl as urban and the rest as rural, it could be safely assumed that there was a wide gap between urban colleges and rural colleges.

Another fact that emerged out of the analysis of theory and practical work based on the Checklist and the institutional time tables clearly showed that there was a disparity in between the two. This clearly indicated that schools and colleges did not exactly go by the time tables, one trend that is not condusive to proper science education. Therefore, the investigator was disappointed to find science education in such poor condition. Science education, unlike other stream has a direct impact on the living standard of society. Therefore, the state government may be wise to invest more in this sector. At the same time, the college authorities and teachers as well as students all have the duty to see that science education is allowed to develop in full bloom.

110

CHAPTER-V

Status of Laboratories, Practical Activities and Time Tables

5.0 Introduction:

The importance of good practical work is widely accepted. *It has been acknowledged that good quality practical work promotes the engagement and interest of students as well as develop a range of skills, science knowledge and conceptual understanding*[11]. It has been observed that it is important to support and promote practical work in science because it:

- Stimulates creativity, curiosity and critical thinking
- Underpins and illustrates concepts, knowledge and principles
- Promotes student engagement with the scientific method
- Encourages active learning and problem-solving
- Allows collaborative working
- Provides opportunities to collect and analyse data and apply mathematical skills.

[11] Practical work in science: a report and proposal for a strategic framework; SCORE(Science Community Representing Education), 6-9 Carlton House Terrace, SW1 Y5AG, 2008.

This does not mean that theory is less important, but that practical work and theory should go hand in hand in order to induce wholesome uncerstanding of science which cannot be achieved with theory alone.

5.1 Rules and Regulations for Affiliation of Science Courses at Different Levels of Education:

According to the National Curriculum Framework 2005, secondary education should be a time to give students a learning experience where they can have a chance to work with their hands and in activities and analysis on issues surrounding environment and health. Systematic experimentation as a tool to discover/ verify theoretical principles, and working on locally significant projects involving science and technology are to be important parts of the curriculum at this stage. At the higher secondary stage, science should be introduced as a separate discipline with emphasis on experiments and problem solving. Science should be a means to stimulate students' creativity and inventiveness.

In accordance to this, the Mizoram Board of School Education has laid down the following rules with regard to infrastructure, equipments, teaching aids, etc for science education at the secondary and higher secondary stages.

A) Rules with Regard to Infrastructure, Equipment, Teaching aids, etc for Science Education at the Secondary Stage:

A High School offering subjects with practical shall have the following infrastructure, equipments, teaching aids, etc, whichever is applicable as listed below or as per the prescription of the Board from time to time:

(iii) A laboratory room to conduct science practical, (Physics/Chemistry/Biology) accommodating a minimum of 20 students at a time, providing a minimum carpet area of 20 (twenty) Square feet per student with necessary equipment.

(iv) A separate room each for Physics, Chemistry and Biology is desirable.

B) Rules with Regard to Infrastructure, Equipment, Teaching aids, etc for Science Education at the Higher Secondary Stage:

Higher Secondary Schools offering subjects with practical shall have the following infrastructure, equipment and teaching aids, etc., whichever is applicable as listed below or as per the prescription of the Board from time to time:

(v) A laboratory room to conduct Physics practical, accommodating a minimum of 24 students at a time, providing a minimum carpet area of 20 (twenty) square feet per student with necessary equipments.

(vi) A laboratory room to conduct Chemistry practical, accommodating a minimum of 24 students at a time, providing a minimum carpet area of 20 (twenty) square feet per student with necessary equipments .

(vii) A laboratory room to conduct Biology practical, accommodating a minimum of 24 students at a time, providing a minimum carpet area of 20 (twenty) square feet per student with necessary equipments

(viii) A store room measuring a minimum carpet area of 256 (Two hundred fifty six) square feet, for the laboratory or laboratories to store respective practical instruments /chemicals /equipments with proper inventory and recording registers.

The above is just a minimum requirement that should be met. This requirement has been clearly laid down by the Mizoram Board of School Education and based on their stipulations for schools who desire to be affiliated to it, the investigator thought it necessary to find out the condition of laboratories in secondary and higher secondary schools.

For this, the investigator thought it was appropriate to select certain schools from government, deficit and private schools as sample for the study. After careful study of schools in different part of the state, 15 higher secondary schools were selected and 25 secondary schools were selected as samples. These made up 5% of the total number of schools.

A checklist containing items laid down by the Mizoram Board of School education was prepared and the investigator visited each of the schools to make sure the responses were made and that they were correct. The following tables show the result of this checklist.

C) Rules with Regard to Infrastructure, Equipment, Teaching aids,etc for Science Education at Higher Education:

As found in the section 'on affiliation of colleges' of Mizoram University, the affiliating body for colleges in the state of Mizoram, colleges offering science need to meet the following terms in order to secure affiliation from the affiliating body:

-For Three Year Degree Course (General), the number of students to be admitted to a degree programme in Science shall not ordinarily exceed 40 in each section.

-the number of students for a practical class shall not exceed 20 under any circumstances.

-In case, the number of students exceeds the prescribed limit the class shall be split into two or more sections so as to bring them within the prescribed norm.

-For three Year Degree Course (Honours), the number of students to be admitted to a degree programme in Science shall not ordinarily exceed 25. In case, the number exceeds the prescribed limit the class shall be split into two or more sections so as to bring them within the prescribed norms.

-The number of students for a practical class however shall not exceed 15 under any circumstance.

- For Science subject there shall be separate Lecture theatre and laboratory rooms with the provision that no student will have less than 2.2 sq. metre floor area for working in the laboratory.

No check list as was prepared for high schools and higher secondary schools could be prepared because the University did not lay down any specifications with regards to the number, amount and quality of apparatus, equipment or materials needed in the laboratories.

5.2 Status of Science Laboratories at Secondary, Higher Secondary and Collegiate Level:

5.2.1 Status of Science Laboratories in High Secondary Schools:

5.2.1.1 Physics

(a) Apparatus and Equipment:

As revealed by Table- 5.1, the apparatus and equipment for practical work in physics was hardly satisfactory at the time the investigation was done. Equipment like concave mirror, convex mirror and plane mirrors were present in more than 80% of the sample high schools. However, galvanometers, horse shoe magnets, maximum and minimum and testers- all of them being important parts of practical works- were present in less than 50% of the sample high schools. It was also seen that materials like magnetic needle, clinical thermometer and electromagnet were present in less than 30% of the schools. It was sad to find that Steel almirahs were absent in 78% of the sample high schools and experiment table were absent in 36% of the sample high schools.

Table-5.1
Percentages of Sample High Schools having Specified Apparatus and Equipment in Physics in Sample High Schools(N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Concave mirror FL-15cm	21	84	04	16
2	Convex mirror 5mm dia FL-10cm@FL20cm	21	84	04	16
3	Plane mirror, 10cmx5cmx3mm	22	88	03	12
4	Convex lens plano FL10cm, FL50cm	18	72	07	28
5	Glass Prisms (equilateral 40mmeach side)	21	84	04	16
6	Glass slab (7.5x5x1.25cm)	19	76	06	24
7	Slide callipers	14	56	11	44
8	Rheostat	19	76	06	24
9	Voltmetre DC with stand, 0-10 volts	18	72	07	28
10	Ammeter with stand DC 0-5 MA	18	72	07	28
11	Galvanometer, weston type	12	48	13	52
12	Physical balance(double pan balance with glass case)	16	64	09	36
13	Concave lens, plano 5cmm dia	20	80	05	20
14	Bar magnet 100m length/alnico, 75mm length	18	72	07	28
15	Horse shoe magnet	13	52	12	48
16	Electromagnet	7	28	18	72
17	Magnetic needle	9	3	16	64
18	Metallic bob, pendulum bob with hook	14	56	11	44
19	Clinical thermometer	8	32	17	68
20	Tuning fork-340hz, 480hz,256-512 hz	10	40	15	60

21	Resistance wire, eureka constant 225 w	5	20	20	80
22	Maximum and minimum thermometer	12	48	12	48
23	Steel almirah 6x3	7	28	18	72
24	Stop watches 0-60secx1/5 sec	15	60	10	40
25	Tester,(electric)	11	44	14	56
26	Multimeter(analogue)	9	36	16	64
27	Battery eliminator	12	48	13	52
28	Extension cord(ISI mark with indicator)	10	40	15	60
29	Flexible wire (0.44mm copper)coil	9	36	16	64
30	Experiment table, 6x4	16	64	09	36

Table-5.2 shows that among the schools where the science apparatus and equipment were found, only 32 % of them had more than 75% of the specified apparatus and equipment. Another 32% had more than 50 % but this was not sufficient for the conduction of a successful physics practical. The fact that 28% of the schools still had less than half of the required apparatus and equipment was certainly not a picture expected of a progressive state. Still worrying than this was that 2% of the schools still had less than 25 percent of the required apparatus and equipment. The above statistics clearly showed that secondary schools in all of the eight districts still functioned much lower than expected in terms of practical work.

The cumulative percentage indicates clearly that while no school had absolutely no apparatus nor equipment, 8% of the schools carry on laboratory work with a bare minimum of 25% of the required materials. A slightly better figure of 36% was the percentage of schools that had between 25% to 50% of the required apparatus and equipment. But it was sad to note that it was less than 68% of the schools that still operated their laboratories with not more than 75% of the required apparatus and equipment.

Table-5.2

Availability of Specified Apparatus and Equipment in Physics in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	8	32	25	100
50%-75%	8	32	17	68
25%-50%	7	28	9	36

Below 25%	2	8	2	8
Nil	0	0	0	0

If this was the amount of equipment present in the schools, there certainly is no hope for good scientific experiments that would give the students sound grounding in science education. It may also be interpreted that most of the schools still depended on theoretical knowledge to learn science because they did not have the required materials to perform qualitative laboratory work.

5.2.1.2 Chemistry:

(a) Apparatus and Equipment:-

Table-5.3

Percentages of Sample High Schools having Specified Apparatus and Equipment in Chemistry Laboratory (N=25)

S.l.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Beakers borosil-500ml,250ml,100ml	24	96	01	4
2	Conical flask borosil-250ml, 100ml	21	84	04	16
3	Testtube borosil-20ml	24	96	01	16
4	Glass funnel, big and small	24	96	01	16
5	Glass rod-300mlx10mm(bundle of 50)	22	88	03	12
6	Glass tube- 300x5mm(bundle of 50)	18	72	07	28
7	Measuring cylinder, borosil glass upto 500ml	19	76	06	24
8	Spirit lamp, brass, good quality, hard	20	80	05	20
9	Tripod stand, triangular top iron 9mm	23	92	02	80
10	Test tube holder, iron , good quality	18	72	07	28
11	Test tube stand(plastic, at least 10 holdes)	22	88	03	12
12	Weight box	19	76	06	24
13	A pair of tongs	12	48	13	52
14	Wire gauge, asbestos coated	17	68	08	32
15	China dish, 70mm dia	22	88	03	12
16	Dropper(5ml holder)	20	80	05	20
17	Volumetric flask, borosil-500ml, 250ml	8	32	17	68
18	Filter paper, standard quality	20	80	05	20
19	Funne;l stand with ring clamp	11	44	14	56
20	Ball and stick model, plastic set	8	32	17	68
21	Hypodermic syringe, plastic-2ml holder	3	12	22	88
22	Glass trough	7	28	18	72
23	Beehive shelf	4	16	21	84

24	Gas jar	12	48	13	52

As seen in Table-5.3, the sample high schools were quite poorly equipped when it came to apparatus and equipment. At the time the study was done, essential items like beakers, conical flasks, glass rods, test tubes, china dish, and tripod stands were present in more than 80 % of the sample high schools. Although this looked reassuring, it meant that more than 20% of the sample high schools did not have these essential items. Items like tongs, funnel stands, volumetric flasks and gas jars were present in less than 50% of the sample schools but the other picture was that nearly 50% of the schools did not have these items.

Table-5.4
Availability of Specified Apparatus and Equipment in Chemistry in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	10	40	25	100
50%-75%	12	48	15	60
25%-50%	2	8	3	12
Below 25%	0	0	1	4
Nil	1	4	1	4

Table-5.4 is clear indicator of the poor condition that secondary schools in Mizoram were allowed to exist. Only 40% of the sample high schools had more than 75% of the required apparatus and equipment in chemistry. A slightly better but nonetheless unhealthy picture was shown by 48% of the schools who had 50% to 75% of the required apparatus and equipment. The fact that 8% of the sample schools had 25% to 50% of the prescribed apparatus and equipment was bad enough, that 4% of the sample schools had none of the prescribed apparatus and equipment was cause for serious concern for science education at the secondary stage.

The frequency percentage clearly indicated that less than 60 percent of the sample high schools had more than 50% of the required apparatus and equipment in chemistry. Even a 50% is still not sufficient to run a good laboratory. Not only will the students be prevented from performing their own experiment but even the teacher will be unable to demonstrate all the necessary experiment for the benefit of the students due to lack of materials. Less than 12% of the sample schools had more than 25% which in reality was not a good amount for even a mediocre laboratory. That 4% of the schools still remained with less than 25% of the required materials and another 4% still remained without a single laboratory apparatus and equipment to show should be a reminder for every educational administrator, concerned school as well as society to be more vigilant of the changes needed to be brought in secondary schools in the state. If the situation is allowed to continue, science will just be a collection of difficult concepts for students and most will choose to opt for other streams when they come to the stage when they can choose among various disciplines.

(b) Chemicals :-

Table-5.5
Percentages of Sample High Schools having chemicals in Chemistry in Sample High Schools(N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Colbalt nitrate	6	24	19	76
2	Anhydrous copper sulphate	14	76	11	24
3	Common salt	13	52	12	48
4	Ammonium chloride	19	76	6	24
5	Acetic acid	19	76	6	24
6	Ammonia soln	13	52	12	48
7	Copper sulphate crystal	14	56	11	24
8	Calcium carbonate	17	68	8	44
9	Copper metal turning	18	72	7	28
10	Formaldehyde	15	60	10	40
11	Ferrous suphate	13	62	12	38
12	Ethyl alcohol absolute 99.9%	10	40	15	60
13	Hydrogen peroxide	9	36	16	64
14	Hydrochloric acid, concentrated	21	84	4	16
15	Iron metal powder	12	48	13	52
16	Iodine	20	80	5	20
17	Magnesium sulphate	9	36	16	64
18	Manganese dioxide	8	32	17	68
19	Mercuric chloride	2	8	23	92
20	Magnesium chloride	8	32	17	68
21	Nitric acid, concentrate	18	72	7	28

22	Pottasium chloride	12	48	13	52
23	Pottasium permanganate	15	60	10	40
24	Phenolpthalein	14	56	11	44
25	Sodium bicarbonate	17	68	8	32
26	Sodium carbonate	15	60	10	40
27	Sodium nitrate	10	40	15	60
28	Sodium hydroxide	18	72	7	28
29	Sodium metal	10	40	15	60
30	Starch soluble	10	40	15	60
31	Silver nitrate	8	32	17	68
32	Sulphuric acid, concentrated	21	84	4	16
33	Zinc sulphate	12	48	13	52
34	Zinc chloride	9	36	16	64
35	Zinc metal	15	60	10	40
36	Zinc carbonate	7	28	18	72

As shown by table-5.5, chemicals like hydrochloric acid, anhydrous copper sulphate, iodine, sulphuric acid and nitric acid were the only chemicals which were present in more than 70% of the sample high schools. But it should not be forgotten that these chemicals were absent in nearly 30% of the sample high schools, a large number considering the vital role they play in experiments. Some of the chemicals like formaldehyde, ferrous sulphate, calcium carbonate, pottasium carbonate and sodium carbonate were present in 60%, 62%, 68%, 60% and 68% respectively. However, chemicals like silver nitrate, zinc carbonate magnesium dioxide and cobaltous nitrate were present in only less than 35% of the sample high schools.

Table-5.6

Availability of Specified chemicals in Chemistry in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	8	32	25	100
50%-75%	4	16	17	68
25%-50%	8	32	13	52
Below 25%	4	16	5	20
Nil	1	4	1	4

Chemicals are a necessity in chemistry laboratory. They are the one area where no compensation can be made because reactions are changed with the absence or presence of one chemical. While some compromise can be made in the case of furniture or equipment, chemical reactions cannot be carried out unless all the required chemicals are present if the desire is to get accurate results. Therefore, the fact that only 32% of the sample high schools had more than 75% of the required chemicals in chemistry as shown in table-5.6 was not a good image. Only 16% of the sample schools have 50% to 75% of the required chemicals. Another 32% of the selected schools had 25% to 50% of the prescribed sample. Last but not least, 4% of the sample high schools still had no chemicals to carry out experiments. This showed that for most schools in Mizoram, science education was just a futile attempt and does not really have a chance to plant the seeds of interest in science in the young minds that make up the population of students in the secondary stage.

Therefore, the fact that 68% of the selected schools had less than 75% of the required materials was worrying. That less than 52% had less than 50% of the specified chemicals was reason enough to embark on a deeper study of supply modes as well as the sum allotted to secondary schools for the development of science education. The fact that 4% of the schools still remained with no chemicals for chemistry was reason to be truly ashamed, both for teachers as well as government. Considering the fact that laboratory practical works carry 25% of the marks in science at the secondary level, the existence of schools with no chemicals to carry out laboratory work showed the negligence of teachers as well as government.

5.2.1.4 Biology:

(a) Apparatus and Equipment:-

Table-5.7

Percentages of Sample High Schools having Specified Apparatus and Equipment in Biology Laboratory (N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%

1	Mortar and pestle, medium size	21	84	4	16
2	Pippette,borosil-10ml	15	60	10	40
3	Dissecting tray(300mmx250mmx65mm-complete white enameledwith wax, good quality)	10	40	15	60
4	Dissecting bbox(comprising 14 instruments, stainless steel-good quality)	12	48	13	52
5	Compound microscope(standard quality eye piece 10x5 magnification 100x675 with box, lock and key)	21	84	4	16
6	Simple/dissecting microscope(good quality)	12	48	13	52
7	Hand lens(sample required)	18	72	7	28
8	Glass slides box(13mmx108mmx38mm standard and index sheet with blue star)	18	72	7	28
9	Cover slip(optically flat in log pack rectangular 20)blue star	17	68	8	32
10	Permanent slides with labelled boxes	17	68	8	32
11	Watch glass, heat proof, transparent and 60,80 diametre	11	44	14	56
12	Charts- vitamins, food chain, food web	13	52	12	48
13	Wide mouth bottle, good quality, 1000ml	7	28	18	72

As indicated by the Table-5.7, among the few apparatus and equipment outlined by the MBSE, only mortar and pestle and compound microscope were the only ones present in more than 80% of the sample high schools. The data showed that items like permanent slides, cover slips, pipette, etc were absent in nearly 50% of the sample high schools. Since biology deals with organic matters, proper apparatus and equipment is a must. Hence it does not bore well for the schools to have such poorly equipped laboratories in this day and age when all states in different regions are on a forward march for development in science education.

Table-5.8

Availability of Specified Apparatus and Equipment in Biology in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	7	28	25	100
50%-75%	9	36	18	72
25%-50%	6	24	9	36
Below 25%	1	4	3	12
Nil	2	8	2	8

Biology is a delicate subject that needs constant supply of materials because many of the apparatus used have a life time and need to be replaced in regular intervals. Due to this it need a dedicated effort in terms of finance and human resource in order to keep it in working condition. Table-5.8 here showed that only 28% of the sample high schools had above 75% of the required apparatus and equipment. It also revealed that only 36% of the high schools selected as sample had 50% to 75% of the required materials. But as mentioned earlier, it would not be possible to carry out all the biological experiments with just 50 to 70% of the required materials. Besides this, 24% of the schools had less than 50% and slightly more than 25%. It was clear that they too will not be able to run a successful biological laboratory. But that 4% of the schools still had less than 25% of the specified apparatus and equipment and that another 8% of the schools still operated their biology classes with no practical work was cause for serious concern for the future of science education. It was obvious that these schools only depended on theoretical knowledge for their students to learn science and they had no chance to understand the beauty of the subject in a practical manner.

The cumulative percentage showed that 72% of the selected sample high schools still had less than 75% of the required apparatus and equipment. Based on this fact, it could also be concluded that 72% of the sample high schools still managed with less than 75% of the required apparatus and equipment. This means that 75% of secondary students will have no opportunity to carry out 75% of the laboratory work. Among this group who had less than 75% of the required apparatus and equipment, 36% have less than 50% of the required apparatus and equipment. This clearly showed that 36% of the sample secondary schools had less than 50% of the required apparatus and equipment to accomplish their allotted laboratory work. That 12% of the sample high schools still had less than 25% of the required apparatus and equipment was sad, but that 8% of the sample schools had no apparatus nor equipment but were still allowed to sit for an examination where 25% of the full mark went to practical work was enough reason to be truly concerned about the current state of affairs and start taking positive steps if one is in the position to do so.

(b) Charts :-

Table-5.9
Percentages of Sample High Schools having Specified charts in Biology Laboratory (N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Charts-Cell division (Mitosis & Meiosis)	16	64	9	36
2	Plant Cell & Animal Cell	14	56	11	44
3	Charts, Model, Diagrams, Specimen of Ancestral forms of Man, Canine & Incisors, Hands of Man & Monkey	4	16	21	84
4	Chart/Diagram-Microscope (Compound & Simple)	7	28	18	72
5	Chart-Human Heart, Reproductive System, Urinary System, Kidney Section	13	52	12	48

Charts tell wonderful stories to students and can accomplish what lengthy lectures fail to achieve. This is why meaningful charts should always be a part of good practical work in science. Table-5.9 here showed that out of the 5 charts, only the charts showing cell division, plant cell, and human heat, reproductive system, urinary system and kidney section were present in more than 50% of the schools. Charts showing models of ancestral home sof man, canine and incisors, hands of man and monkey and diagram of microscope were present only in 16% and 28% respectively. If this was the condition, most of the high schools in Mizoram was not able to provide the right environment for inculcation of scientific attitude in their students.

Table-5.10
Availability of Specified Charts in Biology in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	6	24	25	100
50%-75%	6	24	19	76
25%-50%	4	16	13	52
Below 25%	1	4	9	36
Nil	8	32	8	32

As shown in Table-5.10, 25% of the schools selected as sample high schools had 75% of the required charts. Considering that only 4 different charts were demanded, this was a small number. Even a 100% would not be difficult to attain since charts are easy to obtain. In spite of the fact that charts are one of the least inexpensive items, 24% of the sample schools had 50% to 75% of the required charts only. While 16% of the sample high schools had 25% to 50% of the required charts, 4% had less than 25% of the required charts for biology practical. But the real shame was that 32% of the sample schools did not have any chart. This was indeed poor because charts could be used not only in the laboratory but during class lectures because pictures often spoke louder than words especially in science subjects. In any case the fact that they were so easily available in the common market was reason enough for most schools to acquire them but this did not seem to be the case in the case of secondary schools in Mizoram.

The cumulative percentage also revealed without a doubt that 76% of the sample schools had less than 75% of the required charts. At this point, the investigator would also like to mention that even in the schools where charts were present, they were neatly rolled up and students were even asked not to touch them, let alone study them. Since this did not seem to be the reason why the MBSE demanded charts to be present in the schools, it was really disheartening to see schools not utilizing the charts which are one of the easiest ways to make students understand scientific facts. Besides this, 52% of the sample high schools had less than 50% of the required charts. But 36% of the sample high schools still had less than 25% of the prescribed charts. All these were bad news for a state whose desire was to make maximum use of its human resources to make up for its lack of physical resources but worse than these schools are the rest 32% who have no chart at all. This is not just negligence but sheer ignorance as well. If after more than a decade of living in the 21st century, we still had schools like this the investigator wondered if the state would ever have schools worthy of excellence in science education.

(c) Chemicals :-

Table-5.11

Percentages of Sample High Schools having Specified chemicals in Biology Laboratory (N=25)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Dpx mountant	7	28	18	72
2	Conc.H Cl	18	72	7	28
3	Methylene blue	12	48	13	52
4	Suffranine	18	72	7	28
5	Iodine soln.	19	76	6	24
6	Distilled water	13	52	12	48
7	Conc. HNO3	17	68	8	32
8	Ammonium hydroxide	15	60	10	40
9	Burette reagent	12	48	13	52
10	Millon's reagent	16	64	9	36
11	Sudan III	17	68	8	32
12	Formalin	14	56	11	44
13	Eosin	11	44	14	56
14	Ammonium chloride	15	60	10	40
15	Cotton blue	8	32	17	68
16	Zinc metal	14	56	11	44
17	Marble chips	13	52	12	48

As evident in Table-5.11, vital items like Dpx mountant and cotton blue were present only in 28% and 32% of the sample high schools respectively. Only a few items, namely, suffranine, concentrated hydrochloric acid and iodine solution were found in more than 70% of the sample high schools. The rest of the specified chemicals like distilled water, nitric acid, formalin, zinc metal and marble chips were absent in nearly 50% of the sample high schools. In fact, none of the items were present in all of the sample high schools. Considering the importance of these chemicals, their absence in many of the sample high schools show that practical activities in biology will certainly not be as visualized by the MBSE.

Table-5.12
Availability of Specified Chemicals in Biology in Sample High Schools (N=25)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	9	28	25	100
50%-75%	7	36	18	72
25%-50%	6	24	9	36
Below 25%	1	4	3	12
Nil	2	8	2	8

As indicated by Table-5.12, only 28% of the sample secondary schools had more than 75% of the specified chemicals for carrying out biology practical classes. This meant that only 28% of the schools would be able to carry out at least 75% of the chemical reactions that need to be performed at this level. But 36% of the schools had only 50% to 75% of the prescribed chemicals for biology laboratory. While 24% of the sample high schools had just 25% to 50% of the required chemicals, they still wer in a better than position than the 4% of the sample high schools who had less than 25% of the prescribed chemicals. Having less than 25% of the required chemicals meant that these sample schools would not be able to carry out any of the prescribed laboratory work in biology because each of the chemical reactions involved at least two different types of chemicals.

Moreover, considering that 8% of the schools still had no chemicals at all, it could be assumed that these 8% of the sample schools would not be able to perform any biological reactions in their schools. Their students would be totally dependent on theory classes for their knowledge and this was not a good practice for science education which depends heavily on practical work.

5.2.2 Status of Science Laboratories in Higher Secondary Schools:

5.1.4 Physics:

(a) Apparatus and Equipment:-

Table-5.13

Percentages of Sample Higher Secondary Schools having Specified Apparatus and Equipment in Physics Laboratory(N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Cylindrical Body (2.5 cm)	4	27	11	73
2	Rectangular Block (Wooden)	10	67	5	33
3	Vernier Callipers – Adjustable Steel	14	93	1	7
4	Screw Gauge(Least count 0.001cm-Brass)	14	93	1	7
5	Metallic Wire	7	47	8	53
6	Spherical Ball with hook (Brass)	11	73	4	27
7	Clamp Stand	10	67	5	33
8	Resonance Tube (Brass)	4	27	11	73
9	Rubber Pad/Cork-10,12,14,15,17mm bottom diameter	8	53	7	47
10	Thermometer (half and one degree)	9	60	6	40
11	Thermometer (maximum and minimum)	6	40	9	60
12	Travelling Microscope	8	53	7	47
13	Capitally Tube	0	0	15	100
14	Searl's Apparatus	2	30	13	70
15	Fortin's Barometer with enough mercury	3	20	12	80
16	Helica's Spring up to 1 kilogram	3	20	12	80
17	Metre Scale	9	60	6	40
18	Crocodile Jaw (Clips)	1	7	14	93

19	Soldering Reed (35 watt) and Soldering Pad	5	33	10	67
20	Extension Cord	10	67	5	33
21	Ammeter (0-500)MA, (0-1.5)A	15	100	0	0
22	Voltmeter 0-3, 0-5, 0-10	15	100	0	0
23	Meter Bridge (Complete with Jockey)	15	100	0	0
24	Post Office Box	10	67	5	33
25	Potentiometer (4 wire with Jockey)	12	80	3	20
26	Resistance (diff. Ohm), Carbon Resistors	9	60	6	40
27	Sonometer (AC) with slotted weight and anger 0.5 kg	5	33	10	67
28	Tangent Galvanometer (30-0.30-Moving coil type)	15	100	0	0
29	Optical Bench (Steel-1 meter length, double rod with 4 metal)	15	100	0	0
30	Spherometer (0.55mm-Pitch-70-7 Scale)	9	60	6	40
31	Glass Prism (Equilateral 25mm each side)	13	87	2	13
32	Transistor PNP/NPN (AC 187)	7	47	8	53
33	Illuminator	3	20	12	80
34	Multimeter (Analogue)	12	80	3	20

Cont:Table-5.13

Percentages of Sample Higher Secondary Schools having Specified Apparatus and Equipment in Physics Laboratory(N=15)

35	Spirit Level	7	47	8	53
36	Zener Diodes/Diode	4	27	11	73
37	Rheostat (Long)	14	93	1	7
38	Daniel Gell	4	27	11	73
39	Leclanche Cell	5	33	10	67
40	Magnetic Compass	14	93	1	7
41	Concave and Convex Lenses having short focal length	14	93	1	7
42	Drawing Board	12	80	13	20
43	Keys (Plug Keys-Reversing Keys)	10	67	5	33
44	Lead Acid Accumulators/Rechargeable(0-6 volt)	1	7	14	93
45	Step Up/Down Transformer	3	20	12	80
46	Light Emitting Diode (LED)	1	7	14	93
47	L.D.R(light dependent resistor)	0	0	15	100
48	Wrench Box	1	7	14	93
49	Self Adjusting Cutter	5	33	10	67
50	Striper (MT-02)	1	7	14	93
51	Stabilizer (manual)	6	40	9	60
52	Tester Set	9	60	11	40

shown by Table-5.13, only a few items like ammeter, voltmeter, meter bridge, tangent galvanometer and optical bench were found in all 100% of the sample hig schools. The rest of the items were found only in a few of the sample high schools. Some common items like rectangular block, screw gauge, rheostat, magnetic compass and concave and convex lenses were found in more than 90% of the sample high schools. A few more items like clamp stand, thermometer, metre scale, helic's spring, carbon resistors, spherometer, keys and tester set were present in 60% and slightly more than 60% of the sample high schools. Other than the ones mentioned, items like cylindrical body, soldering reed, sonometer, extension cord, diode, lechlanche cell, transformer and self adjusting cutter were present in less than 35% of the sample high schools. Besides this, it was unsettling to see that capillary tube and light dependent resistor were absent in 100% of the schools.

Table-5.14
Availability of Specified Apparatus and Equipment in Physics laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	0	0	15	100
50%-75%	9	60	15	100
25%-50%	4	27	6	40
Below 25%	2	13	2	13
Nil	0	0	0	0

As shown by Table - 5.14, none of the sample higher secondary schools had above 75% of the specified apparatus and equipment in physics. This meant that no school had the required amount of apparatus and equipment to give their student the maximum experience in physics. At the same time,it was also seen that 60% of the schools have only 50% to 75% of the required apparatus and equipment. This is the highest percentage in terms of presence of laboratory equipment and apparatus. This showed that there was a very low level of development especially in the case of physics practical work. The table showed that 27% of the schools had 25% to 50% of the required materials in physics. It is quite obvious that these schools would not be able to perform as well as the previous gruops in physics practical work. It could also be seen that 13% of the schools had below 25% of the required materials. Since they would not be able to perform any of the prescribed expreiments to satisfaction, neither the students nor the teacher would get much opportunity to have depper and more meaningful understanding of the subject. At the same time, as shown by the same table, no sample higher secondary school was found with absolutely no apparatus and equipment in physics. Although the sample schools did not show outstanding results in terms of having the required amount of materials, it was a good sign that they had at least a small amount of apparatus and equipment in physics.

5.2.2.2 Chemistry:

(a) Apparatus and Equipment:-

Table-5.15
Percentages of Sample Higher Secondary Schools having Specified Apparatus and Equipment in Chemistry Laboratory (N=15)

S.L. No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Burette (Torson) – 50ml (Plastic)	14	93	1	7
2	Beakers-500ml, 250ml, 100ml	15	100	0	0
3	Conical flask-250ml,100ml	15	100	0	0
4	Pipette	14	93	1	7
5	Test tube-10ml,20ml,	14	93	1	7
6	Reagent Bottle-1000ml,250ml,500ml	14	93	1	7
7	Funnel(small size glass)	15	100	0	0
8	Glass rod-300x10mm-4mm dia.	14	93	1	7
9	Glass tube-300x5mm	12	80	3	20
10	Volumetric Flask-1000ml,500ml,250ml	12	80	3	20
11	Almirah , wooden 3x6 ft	13	87	2	13
12	Water tanky, syntex-2000lt, export quality	9	60	6	40
13	Burette stand, plastic	13	87	2	13
14	Tripod stand(triangular iron top-9mm)	14	93	1	7
15	Blow pipe, metallic standard	6	40	9	60
16	Cork borer(set of 6 standard-iron)	9	60	6	40
17	Wire gauge(asbestos coated)	14	93	1	7
18	China dish(porcelain dish-70mm dia)	15	100	0	0
19	Mortar and pestle(porcelain)	14	93	1	7
20	Test Tubebrush(good quality)	14	93	1	7
21	Burette Brush(galvanised wire with handle)	5	33	10	67
22	Wash Botle(plastic LD, good quality with nozzle)	11	73	4	27
23	Platinum wire embodied in glass rod	11	73	4	27

24	Hot plate(good quality)	5	33	10	67
25	Hot water bath(good quality with at least 8 holes)	5	33	10	67
26	Spatula(iron)	12	80	3	20
27	Filter paper(wa1tman's)	12	80	3	20
28	Refrigerator	3	20	12	80
29	Electric balance	12	80	3	20
30	Universal indica1tors(solution or paper)	13	87	2	13
31	pH paper	13	87	2	13
32	Measuring cylinder	11	73	4	27
33	10ml,50ml,100mml,500ml	6	40	9	60
34	Long form of periodic table	11	73	4	27
35	Watch glass(big size glass)	11	73	4	27
36	Thermometer 100degrees Celsius and above, plastic	12	80	3	20
37	Overhead projector	3	20	12	80
38	Bunsen burner	13	87	2	13

As shown by the cumulative frequency, less than 100% of the schools had 50% to 75% of the required apparatus and equipment in physics. The table also revealed that 40% of the schools had less than 50% of the required materials; a clear indicator that they would not accomplish much in terms of physics experiment. It was also found that 13% of the schools had less than 25% of the required apparatus and equipment in physics. All these showed that the state was still in its initial stage of development even after more than 10 years of introduction to science stream at the higher secondary level.

As can be seen in Table-5.15 items like beakers, conical flasks, funnel and china dish were found in 100% of the schools. But these were bare essentials and most of the required items for successful practical work were absent in the schools. Items like glass rods, mortar and pestle, wash bottles, reagent bottles etc were found in more than 70% of the sample high schools. But very important items like hot plates, hot water bath, refrigerators and overhead projectors were present in less than 33% of the schools. It was not at all satisfying to see that crucial items like the ones mentioned here were found in such a small percentage.

Table-5.16
Availability of Specified Apparatus and Equipment in Chemistry Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	9	60	15	100

50%-75%	5	33	6	40
25%-50%	1	7	1	7
Below 25%	0	0	0	0
Nil	0	0	0	0

Before considering other aspects of a good laboratory in any subject, adequate apparatus and equipment is a must. In the study done on the 15 sample higher secondary schools, as shown by Table-5.16 , only 60% of them had 75% of the minimum requirement made by the MBSE. This in itself showed that only 60% of the sample higher secondary schools provided a moderate environment for their students to perform their experiments. While 33% of the schools had 50% to 75% of the required apparatus and equipment, 7% of the sample schools still managed with less than 50% of the required materials. This is not a good picture considering that at this level, 30% of the total marks is allotted for practical work.

If one read the cumulative percentage carefully, 40% of the sample schools had less than 75% of the required apparatus and equipment. Another 75% had less than 50% of the minimum requirement made by the MBSE for the equipment of chemistry laboratory. Therefore, it is clear that these sample schools which have been selected from various districts will certainly not be able to provide the necessary equipment for their students. The sad news was that it was not just this level that would suffer but college education as well because these students were future college students. More serious that this was that these very students were the ones who would be teaching science in our future classrooms. A person who was not taught the full import of laboratory work would never be able to teach his students the importance of laboratory work in science education.

(b) Chemicals :-

As seen in table-5.17, the MBSE had prescribed a total of 162 chemicals for a higher secondary school chemistry laboratory. For the sake of convenience, as in other tables, only a few of the items have been mentioned although calculation was done for all the items. Among the items expected to be present in a chemistry laboratory, ammonium ferrous sulphate, ammonium sulphate, hydrochloric acid and oxalic acid were the only ones found in 100% of the sample higher secondary shcools. A few of the items like ammonium nitrate, ammonium oxalate, benzene, cupric carbonate, dimethyl glyoxime, cobalt nitrate, ferric nitrate, iron metal powder, lead dioxide, pottassium nitrate, sodium sulphate and litmus blue etc. were found in 60% or slightly more percentage of the sample higher secondary schools. But worse than this was that there were still a number of items that were found in less than 50% of the schools. Items like ammonium phosphate, acetaldehyde solution, cadmium sulphate, disodium hydrogen phosphate, nessler's reagent, picric acid etc were absent in more than 60% of the sample higher secondary schools. But items like schiff's powder, furural solution were present in less than 10% of the schools whereas sodium citrate was absent in all the sample higher secondary schools. All these indicated that chemistry practical work would certainly not be as vigorous as was expected in the higher secondary section.

Table-5.17
Percentages of Sample Higher Secondary Schools having Specified Chemicals in Chemistry Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Ammonium Molybdate 500g	10	67	5	43
2	Ammonium Carbonate (Purified or AR) 500g	14	93	1	7
3	Ammonium Chloride AR 500g	12	80	3	20
4	Ammonium Sulphate AR 500g	15	100	0	0
5	Ammonium nitrate AR 500g	14	93	1	7
6	Ammonium phosphate 500g	6	40	9	60
7	Ammonium ferrous sulphate AR 500g	13	87	2	13
8	Ammonium ceric nitrate AR 500g	9	60	6	40
9	Ammonium oxalate AR 500g	12	80	3	20
10	Ammonium thiosyanide AR 500g	7	47	8	53
11	Ammonium acetate AR 500g	11	73	4	27
12	Ammonium sulphide 500g	9	60	9	40
13	Aluminium nitrate AR 500g	10	67	5	43
14	Aluminium chloride(hydrated AR) 500g	10	67	5	43
15	Aluminium sulphate AR 500g	9	60	6	40
16	Acetic Acid(glacial AR) 500ml	13	87	2	13
17	Aniline AR 500ml	13	87	2	13
18	Acetone (EL) 500ml	13	87	2	13
19	Acetanilide 500ml	5	33	10	67
20	Acetaldehyde soln.500ml	10	67	5	33
21	Ammonia soln. 500ml	13	87	2	13
22	Bromide water(AR 5x20ml)	10	67	5	33
23	Barium nitrate AR 250g	13	87	2	13
24	Barium chloride AR 250g	14	93	1	7
25	Barium carbonate AR	8	53	7	47
26	Benzoic acid AR 250g	10	67	5	33

27	Benzaldehyde AR 500ml	12	80	3	20
28	Benzene Ar 250g	12	80	3	20
29	Boric acid(crystals AR) 500g	8	53	7	47
30	Benzene crystallizable 500g	4	27	11	73
31	Barium sulphate AR 250g	12	80	3	20
32	Copper sulphate(crystals, soln)500g	12	80	3	20
33	Cupric carbonate 500g	11	73	4	27
34	Cupric chloride AR 500g	12	80	3	20
35	Cupric nitrate 500g	12	80	3	20
36	Calcium chloride dihydride AR 250g	11	73	4	27
37	Calcium sulphate dihydrude AR 250g	10	67	5	33
38	Calcium oxide lumps AR	6	40	9	60
39	Calcium tetrahydride AR	1	7	14	93
40	Calcium carbonate 500g	13	87	2	13
41	Carbon di sulphide AR	5	33	10	67
42	Cadmium sulphate AR	6	40	9	60
43	Cadmium chloride	7	47	8	53
44	Carbon tetrachloride AR	9	60	6	40
45	Copper metal turning	14	93	1	7
46	Chloroform, AR/dry AR	13	87	2	13
47	Cobalt nitrate	11	73	4	27

Cont: Table-5.17
Percentages of Sample Higher Secondary Schools having Specified Chemicals in Chemistry Laboratory (N=15)

48	Charcoal block, activated charcoal AR	8	53	7	47
49	Dimethyl glyoxime AR	12	80	3	20
50	Disodium hydrogen phosphate	7	47	8	53
51	Diethyle ether AR	9	60	6	40
52	2,4 dinitrophenyl hydrazine	11	73	4	27
53	Formaldehyde(diethyl acetal AR)	11	73	4	27
54	Ferrous sulphide	12	80	3	20
55	Ferrous sulphate AR	13	87	2	13
56	Fehlings soln A	15	100	0	0
57	Fehlings soln B	15	100	0	0
58	Ferric chloride	14	93	1	7
59	Ferric nitrate AR	10	67	5	43
60	Ethyl alcohol absolute 99.9% omnis	12	80	3	20
61	Glycerol-glycerine AR	7	47	8	53
62	Hydrogen peroxide 1000ml	10	67	5	33
63	Hydrochloric acid 500lt	15	100	0	0
64	Iron metal powder	8	53	7	47
65	Iodine resublimed	11	73	4	27
66	Lead dioxide or peroxide	11	73	4	27
67	Lead acetae AR	12	80	3	20
68	Lead bromide	10	67	5	33
69	Lead nitrate	12	80	3	20
70	Lead chloride	11	73	4	27
71	Manganous sulphate	10	67	5	33
72	Magnesium sulphate	12	80	3	20
73	Manganese dioxide	10	69	5	31
74	Mercury metal	8	53	7	47
75	Mercuric chloride	5	33	10	67
76	Mercurous nitrate	4	27	11	73
77	Methanol	11	73	4	27
78	Methyl orange	12	80	3	20
79	Manganous chloride	12	80	3	20
80	Mercuric nitrite	4	27	11	73
81	Magnesium chloride	10	67	5	33
82	Nickel chloride	10	67	5	33
83	Nickel sulphate	9	60	6	40
84	1 napthol	13	87	2	13

85	2 napthol	12	80	3	20
86	M nitrobenzene	8	53	7	47
87	Ninhydrine	7	47	8	53
88	Nessler's reagent	12	80	3	20
89	Nittric acid 2.5lts	15	100	0	0
90	Oxalic acid	15	100	0	0
91	Potassium chloride	14	93	1	7
92	Potassium hydroxide	14	93	1	7
93	Potassium iodide	12	80	3	20
94	Potassium dichromide	12	80	3	20
95	Potassium chromate	12	80	3	20
96	Potassium nitrate	10	67	5	33
97	Potassium carbonate	13	87	2	13
98	Potassium ferricyanide	12	80	3	20
99	Potassium sulphocyanide	6	40	9	60
100	Potassium pyroantimonate	2	13	13	87
101	Potassiumferrocyanide	12	80	3	20
102	Potassiumthiocyanide	13	87	2	13
103	Picric acid	5	33	10	67
104	Phenolpthalein	12	80	3	20
105	Pathallic anhydride	2	13	13	87
106	Sodium bicarbonate	13	87	2	13
107	Sodium carbonate	14	93	1	7
108	Sodium sulphide	7	47	8	53
109	Sodium bromide	6	40	9	60
110	Sodium acetate	9	60	6	40

Cont: Table-5.17

Percentages of Sample Higher Secondary Schools having Specified Chemicals in Chemistry Laboratory (N=15)

111	Sodium iodide	6	40	9	60
112	Sodiumnitrate	11	73	4	27
113	Sodium hydroxide	13	87	2	13
114	Sodium nitroprusside	12	80	3	20
115	Sodium chloride	14	93	1	7
116	Sodium sulphate	9	60	6	40
117	Sodium bisulphate	8	53	7	47
118	Sodium thiosulphate	9	60	6	40
119	Sodium metal	11	73	4	27
120	Salicylic acid	5	33	10	67
121	Stannous chloride	9	60	6	40
122	Starch soluble	10	67	5	33
123	Strontium chloride	7	47	8	53
124	Schiff's powder	1	7	14	93
125	Sulpher powder	9	60	6	40
126	Silver nitrate	13	87	2	13
127	Sulphuric acid	14	93	1	7
128	Sodium sulphite	9	60	6	40
129	Strontium nitrate	8	53	7	47
130	Sodium bisulphate	5	33	10	67
131	Urea	12	80	3	20
132	Universal indicator(soln or paper)	10	67	5	33
133	Xylene	2	30	13	70
134	Zinc sulphate	12	80	13	20
135	Zinc chloride	12	80	3	20
136	Zinc metal	8	53	7	47
137	Zinc carbonate	10	67	5	33
138	Zinc nitrate	10	67	5	33
139	Sodium citrate	0	0	15	100
140	Atomic model set	2	30	13	70
141	Potassium hydrogen sulphide	5	33	10	67
142	Potassium bromide	4	27	11	73
143	Potassium sulpho cyanide	2	30	13	70
144	Nickel carbonate	4	27	11	73
145	Cobalt acetate	3	20	12	80
146	Magnesium acetate	4	27	11	73
147	Magnesium nitrate	9	60	6	40
148	Cobalt chloride	5	33	10	67
149	Sodium cobalt nitrate	3	20	12	80
150	Thiourea	5	33	10	67
151	Litmus blue(solid)	9	60	6	40
152	Diethyl amine	5	33	10	67
153	Potassium permanganate	13	87	2	13
154	pH paper	13	87	2	13
155	Spirit	12	80	3	20
156	Furfural soln.	1	7	14	93
157	Citric acid	3	20	12	80
158	Acetyl chloride	4	27	11	73
159	Benzene sulphanyl chloride	5	33	10	67
160	Phenol	11	73	4	27
161	Lucas reagent	3	20	12	80
162	Tollen's reagent	11	73	4	27

Chemistry laboratories cannot function without chemicals. So a chemistry laboratory without chemicals is like a classroom without students. It is just like an ordinary room and has no special quality at all. But as indicated by Table-5.18, only 40% of the sample higher secondary schools had above 75% of the minimum requirement made by the MBSE, showing that just 40% of the sample higher secondary schools were able to provide their students with barely standard laboratory work. Since another 40% of the sample higher secondary schools had only 50% to75% of the required chemicals, it was clear that 40% of the sample schools were not be able to provide a wholesome experience to their students. But that 3% of the sample higher secondary schools had less than 50% of the required chemicals showed that even before facing their final examinations, these schools were already at a disadvantage. Since this is the stage where student begin to study their chosen fields, they deserve to be given the best experience that the state can afford. That there were schools that survived with just the bare minimum while Mizoram should be competing with the biggest states in the country was not only detrimental to the development of science education but also to the development of the state considering the vital role science plays in overall development.

Table-5.18
Availability of Specified Chemicals in Chemistry Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	6	40	15	100
50%-75%	6	40	9	60
25%-50%	3	20	3	20
Below 25%	0	0	0	0
Nil	0	0	0	0

In the same table, one could see that 60% of the sample higher secondary schools still had less than 75% of the minimum required chemicals. Since even a 100% would only be a minimum requirement, this was a dismal picture indeed. That 20% of these sample higher secondary schools managd with less than 50%

of the required chemicals showed the poor quality of science education that students received even at this crucial stage where students start to devote themselves fully to their chosen fields. With less than 50% of the minimum requirement of chemicals made by the MBSE, it was clear that these schools were not be able to run their laboratories the way they were meant to be run. This clearly was not the ideal atmosphere for the cultivation of interest in science.

5.2.2.3 Biology:

(a) Apparatus and Equipment:-

Table-5.19

Percentages of Sample Higher Secondary Schools having Specified Apparatus and Equipment in Biology Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Incubator	2	13	13	87
2	B.O.D. Bottles	5	34	10	66
3	Burette Stand (Plastic-White)	4	27	11	73
4	Centrifugator	0	0	15	100
5	Bell Jar	4	27	11	73
6	Dryer (Phillips)	1	7	14	93
7	Cotton Wool	12	80	3	20
8	Filter Paper	12	80	3	20
9	Ph Meter	7	47	8	53
10	Gas Connection	0	0	15	100
11	Dissecting Tray (300mm x 250mm x 65mm - Complete white enameled complete with wax- good quality)	9	60	6	40
12	Dissecting Set(Comprising 14 instruments, stainless steel–good quality)	10	67	5	33
13	Compound Microscope (Standard quality eye piece x 10 x 15 (noth mygenian) magnification 100 x 675 x with bx, lock and key - good quality)	14	94	1	84
14	Simple Microscope (Good quality)	9	60	6	40
15	Slides (In box-25 slides size 130mm x 108mm, 38mm standard with index sheet)	13	87	2	13
16	Cover Slips (Circular)	14	94	1	6
17	Petri Dish (100mm x 15mm depth)	13	87	2	13
18	Cancet	3	20	12	80
19	Test Tube Stand (At least 10 holders)	13	87	2	13
20	Crucible	9	60	6	40
21	Droppers – 5ml	14	94	1	6
22	Wide Mouth Bottles – 1000ml	9	60	9	40
23	Maximum & Minimum Thermometer (Dimple Brand)	8	54	7	46
24	Hammer (Small- good quality)	7	47	8	53
25	Rubber Stopper fit for 10, 20, 30mm diameter	9	60	6	40
26	Pipette – 5ml, 10ml, 20ml	11	74	4	26
27	Lab Stand Set	2	13	13	87

28	Test Tubes – 20ml, 50ml (Hard Glass)	**11**	**74**	**4**	**26**
29	Test Tube Holder (Iron – good quality) set	**13**	**87**	**2**	**13**

As could be gathered from table-5.19, only a few of the specified apparatus and equipment like cotton wool, filter paper, petri dish, test tube stand, droppers and test tube hoders were found in more than 80% of the sample higher secondary schools. The rest of the items were present only in small amounts. Apparatus like incubator, cancet and lab stand set, burette stand and dryer were found in less than 30% of the sample higher secondary schools. But the real situation of the biology laboratory was seen in the total absence of items like centrifugator and gas connection were totally absent from the sample higher secondary schools.

Table-5.20

Availability of Specified Apparatus and Equipment in Biology Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	1	7	15	100
50%-75%	9	60	14	93
25%-50%	4	26	5	33
Below 25%	1	7	1	7
Nil	0	0	0	0

Biology comes under life sciences. As such it mostly deals with perishable specimens that need to be handled with care and with good equipment. This is why it demands an adequate supply of good quality apparatus and equipment. However, Table-5.20 here showed that only 7% of the sample higher secondary schools had above 75% of the required apparatus and equipment. This meant that 93% of the sample higher secondary schools operated with less than 75% of the required apparatus and equipment. A huge 60% of the sample higher secondary schools still had only 50% to 75% of the prescribed apparatus and equipment. Another 26% managed with 25% to 50% of the required materials while 7% still had less than 25 % of the required apparatus and equipment. At this pivotal stage where their performance predicts their whole future as far as professions are concerned, it was indeed cause for worry that the laboratories were so ill equipped.

A look at the last column in this table revealed that a staggering 93% of the sample higher secondary schools had less than 75% of the required apparatus and equipment. Considering that students had to face their final examination where 30% of the full marks belong to practical work, it was not proper that schools that did not have the full equipment were still allowed to run. It also showed sheer negligence on the part of teachers, concerned department as well as the government that so many schools were still left with such a poor supply of apparatus and equipment. That 33% of the sample higher secondary schools had less than 50% of the required apparatus and equipment was a clear indicator that the students in different schools had varying levels of opportunities. This meant that there was unequal competition starting from the learning environment itself.

(b) Chemicals :-

Table-5.21

Percentages of Sample Higher Secondary Schools having Specified Chemicals in Biology Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Aceto-Carmine	13	87	2	13
2	Carmine MS	5	34	10	66
3	Iodine Pellets	4	27	11	73
4	Starch- Powder	13	87	2	13
5	Leishman's Stain	12	80	3	20
6	Sucrose Powder	11	74	4	26
7	Glucose Powder	8	54	7	46
8	Benedict's Reagent	14	94	1	6
9	Sulphosalicylic Acid	5	40	10	60

As indicated by Table-5.21, none of the chemicals were present in 100% of the sample higher secondary schools. Items like acetocarmine, starch powder, Leishman's stain and Benedict's Reagent were present in 87%, 87%, 80% and94% respectively in the sample higher secondary schools. But a very opposite picture was seen in the rest of the items like carmine MS, Iodine pellets and sulphosalicylic acid were found in only 40% or less percentage of the sample higher secondary schools.

Table-5.22

Availability of Specified Chemicals in Biology laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	5	33	15	100
50%-75%	8	53	10	67
25%-50%	1	7	2	14
Below 25%	0	0	1	7
Nil	1	7	1	7

Biology practical cannot survive without proper chemicals. That is why this 33% of sample higher secondary schools will be in a far better situation when it comes to providing incentives to their students because they had more than 75% of the required chemicals for performing biological experiments as indicated in Table-5.22. But since 53% of the sample higher secondary schools had only 50% to 75% of the required chemicals, it was clear that a larger portion of these higher secondary schools had no proper means to conduct successful experiments. While it was sad to note that 7% of the sample higher secondary schools had just 25% to 50% of the necessary chemicals, it was alarming to note that 7% of the sample higher secondary schools did not have one item in the list. If this 7% of the sample schools did not show some positive change, it could be predicted that in a few years to come, the percentage of schools that fell in this category would rise and there will surely be a general decline in science education.

The cumulative percentage showed that 67% of the sample higher secondary schools had less than 75% of the required chemicals. In a situation where practical works took up 30% of the mark in the final examination, this surely had to be noted as dangerous. The 14% that had 50% to 75% might be able to survive barely, but the last two groups each taking up 7% of the total sample higher secondary schools had less than 25% and absolutely no chemical in stock would have no opportunity to show their students the beauty of biology. This was sad in a state like this where an interest in life sciences would benefit it so deeply.

(c) `Permanent Slides:-

As shown by Table-5.23, only a small number of the items like T.S of hydra, mitosis cell division, meiosis cell division, and a few of the T.S(transverse section) of plants body were found in 80% or slightly more percentage of the sample higher secondary schools. On the other hand, essential slides like frog's blood smear, unstriated muscles, squamous epithelium, euglena etc were found in only less than 68% of the sample higher secondary schools.

Table-5.23

Percentages of Sample Higher Secondary Schools having Specified Permanent Slides in Biology Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	T.S. of Nerve Cells	10	67	5	33
2	T.S. of Hydra	13	87	2	13
3	Mitosis Cell Division (All Stages)	12	80	3	20
4	Meiosis Cell Division (All Stages)	12	80	3	20
5	Human Blood Smear	10	67	5	33
6	Frog Blood Smear	9	60	6	40
7	Striated Muscles	10	67	5	33
8	Un-striated Muscles	9	60	6	40
9	Cardiac Muscles	9	60	6	40
10	Squamous Epithelium	10	67	5	33
11	T.S. of Dicot Stem	13	87	2	13
12	T.S. of Monocot Stem	13	87	2	13
13	T.S. of Dicot Root	12	80	3	20
14	T.S. of Monocot Root	11	74	4	26
15	Bacteria	12	80	3	20
16	Leaf Stomata	11	74	4	26
17	Sclerenchyma, Parenchyma, Xylems, Phloem, Nostoc, Spirogyra, Oscillatorin, Rhizopus, Anabourn	10	67	5	23
18	Amoeba	12	80	3	20
19	Paramecium	11	74	4	26
20	Euglena	10	67	5	33

Table-5.23 here indicates without a doubt that only 67 % of the sample higher secondary schools had more than 75% of the total permanent slides as prescribed by the MBSE. Another 20% had just 50% to 75% of the required permanent slides. But the worst picture was shown by the 13% from the sample higher secondary schools that had no permanent slides at all. Even if the students from these schools were to be successful in their examinations and thus had a chance to take up science in college, it could be asserted that these students would have the added burden of familiarizing themselves with permanent slides while competing with students who have already been exposed to them. This burden will surely slow them down and could ruin their chances for better participation in college examinations.

Table-5.24

Availability of Specified Permanent Slides in Biology laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	10	67	15	100
50%-75%	3	20	5	33
25%-50%	0	0	2	13
Below 25%	0	0	2	13
Nil	2	13	2	13

(d) Specimens:-

Table-5.25

Availability of Specified Specimens in Biology laboratory in Sample Higher Secondary Schools (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Mosses	8	54	7	46
2	Fern Plant	9	60	6	40
3	Pitcher Plant	7	47	8	53
4	Mildew	6	40	9	60
5	Rust	6	40	9	60
6	Smut	8	54	7	46
7	Potato Blight	11	74	4	26
8	Life Cycle of Silk Moth	11	74	4	26
9	Life Cycle of Frog	12	80	3	20
10	Life Cycle of Honey Bee	8	54	7	46
11	Life Cycle of House Fly	5	34	10	66
12	Life Cycle of Butterfly	8	54	7	46
13	Root Nodules of Legumes	7	47	8	53
14	Liverworts	4	27	11	73
15	Rhizobium	10	67	5	33
16	Fungi (Mushroom)	10	67	5	33
17	Cuscuta	3	20	12	80
18	Hydrilla	11	74	4	26
19	Drocera	1	7	14	93
20	Cactus	9	60	6	40
21	Euphorbia	2	13	13	87
22	Fishes - Shark, Rohu, Anabus, Catla, Common Carp, Grass Carp	7	47	8	53
23	Salamander	3	20	12	80
24	Toad	12	80	3	20
25	Snakes, Lizards, Tortoise, Octopus	7	47	8	53
26	Octopus	6	40	9	60

27	Torpedo	1	7	14	93
28	Pigeon, Parrot, Sparrow	4	27	11	73
29	Rat, Rabbit	3	20	12	80

As seen from Table-5.25, the presence of specimens was also far from satisfactory. Specified specimens like life cycle of frog and toad were the only ones present in 80% of the sample higher secondary schools. Items like fern plant, smut, life cycle of honey bee, life cycle of butterfly, fungi etc. were present only in slightly more than 50% of the sample higher secondary schools. It was disappointing to see liverworts, rhizobium, salamander and pigeon etc. Only in a little more than 20% of the sample higher secondary schools. In fact, specimens of drocera and that of torpedo were found in only 7% of the sample higher secondary schools. All these pointed to the fact that higher secondary schools had poorly equipped biology laboratories even after 15 years of having introduced the subject.

Table-5.26

Availability of Specified Specimens in Biology Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Apparatus & Equipment)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	2	13	15	100
50%-75%	3	20	13	87
25%-50%	5	34	10	67
Below 25%	2	13	5	33
Nil	3	20	3	20

Specimens play an important part in biology because this is the one way that most of them can be displayed in the laboratory. Most of them are perishable and need to be replaced with fresh ones after some years have passed. This is why they need to be maintained as carefully as is possible.

Table-5.26 here shows that only 13% of the sample higher secondary schools had more than 75% of the specified specimens for biology practical class. A large 20% of the sample higher secondary schools had 50% to 75% of the necessary specimens but a larger 34% of these sample higher secondary schools still managed with 25% to 50% of the specified specimens. While 13%

of the sample schools had less than 25% of the prescribed specimens, the ones that had no specimens at all made up 20% of the sample higher secondary schools. It was clear that the last 3 groups had no chance to show their students these specimens which were not part of the natural fauna of the land. Therefore, students would have only a vague idea of what these are. This kind of situation was certainly not conducive to a lively interest in science education.

Further study of Table-5.26 with more focus on the the cumulative curve reveals that 87% of the sample higher secondary schools had less than 75% of the selected specimens. Another group that made up 67% of the sample higher secondary schools had less than 50% of the required specimens. But while 33% of the sample higher secondary schools had less than 25% of the required specimens, 20% of the sample higher secondary schools did not have any of the required specimens. The last 20 % was a dangerous number because they might have enough number to pull down the overall quality of science education in the state. All these clearly told a sad story where the victims would not just be the students at the level but the whole educational system, especially the section where science education took up space.

(e) Charts:-

As can be seen from Table-5.27, none of the charts were found in more than 75% of the sample higher secondary schools. Charts showing cell division and plant and animal cells were the only ones present in 74% of the sample higher secondary schools. But charts showing transverse sections of stems, roots, plant kingdom classification, internal structure of heart etc and few other were present in slightly more than 60% of the sample higher secondary schools. But infloroscence, cell organellsand biogeochemical cycles were absent in more than 60% of the sample higher schools.

As evident in Table-5.28, it was apparent that only 34% of the selected charts were present in more than 75% of the sample higher secondary schools. While 27% of the charts could be found in between 50% to 75 % of the selected higher secondary shcools, it was sad to note that 13% of the charts which had been selected to be displayed were not found in any of the sample higher secondary schools. All these show that harts were certainly not a priority in the education of biology at this level.

Table-5.27
Percentages of Sample Higher Secondary Schools having Specified Charts available in Biology Laboratory(N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Cell Division (Mitosis & Meiosis) – Different Stages	11	74	4	26
2	Biogeochemical Cycles (Nitrogen, Co_2, O_2, Phosphorous, Sulphur)	4	27	11	73
3	T.S. of Stem – Dicot and Monocot	10	67	5	33
4	T.S. of Root – Dicot and Monocot	10	67	5	33
5	Secondary Growth of Dicot and Monocot Stem	5	34	10	66
6	Plant Cell and Animal Cell	11	74	4	26
7	Classification of Animal Kingdom	9	60	6	40
8	Classification of Plant Kingdom	10	67	5	33
9	Internal Structure of Heart, Kidney, Lungs and Ovary	10	67	5	33
10	Different Types of Tissue Systems (Animal & Plant)	7	47	8	53
11	Respiratory System, Reproductive System, Circulatory System, Skeletal System, Excretory System and Muscular System of Man	9	60	6	40
12	Cell Organelles (Mitochondria, Nucleus, Chloroplast, Cell Wall, Ribosomes, Endoplasmic Recticulum, Golgi Body, Cilia, Flagella, Centriole, Plasma Membrane, Plastids)	6	40	9	60
13	Life Cycle of Frog, Silk Moth, Mushroom, Fern, Moss, Rhizopus, House Fly, Butterfly	8	54	7	46
14	Infloresence (Different types)	2	13	13	87
15	Digestive System of Human Beings	9	60	6	40
16	Floral Parts (China Rose, Mustard)	8	54	7	46
17	Structure of Human Brain	9	60	6	40
18	Models of DNA	9	60	6	40
19	Models of RNA	8	54	7	46

Table-5.28
Availability of Specified Charts in Biology Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Charts)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	5	34	15	100
50%-75%	4	27	10	66
25%-50%	2	13	6	39
Below 25%	2	13	4	26
Nil	2	13	2	13

(f) Furniture :-

Table-5.29
Percentages of Sample Higher Secondary Schools having Specified furniture in Biology Laboratory (N=15)

Sl.No.	Particulars	Status of Availability			
		Yes	%	No	%
1	Steel Almirah (Big- Godrej)	5	34	10	66
2	Towels	10	67	5	33
3	Wooden Stools (3ft Height)	8	54	7	46
4	White Board	9	60	6	40
5	Practical Tables (6ft x 3 ft – Wooden)	11	74	4	26
6	Table with Chair (Wooden)	11	74	4	26
7	Wooden Almira (6ft x 3ft)	14	94	1	6
8	Buckets (Big-Plastic)	13	87	2	13
9	Plastic Mugs (Big)	13	87	2	13

A critical analysis of Table-5.29 disclosed the fact that the furniture such as wooden almirah, tables with chairs, practical tables, buckets and plastic mugs etc were available in 74% to 94% sample schools. Whereas the steel almirah, white board and wooden stools were only available in 34%, 54% and 60% of sample schools, respectively. Most of the sample schools showed that they had a bare minimum when it came to the furniture. Even schools situated in Aizawl, the capital city, did not have the required amount of good furniture. All these was proof that higher secondary schools were in no way properly equipped with regard to the specified furniture/articles in their biology laboratories.

Table-5.30
Availability of Specified furniture in Biology Laboratory in Sample Higher Secondary Schools (N=15)

Class Intervals (Availability of Furniture)	Frequency(n)	Percentage	Cumulative Frequency	Cumulative Percentage
Above 75%	6	40	15	100
50%-75%	5	33	9	60
25%-50%	3	20	4	27
Below 25%	0	0	1	7
Nil	1	7	1	7

A quick glance at Table-5.30 gives a gestalt view of the availability of specified furniture in sample higher secondary schools. Perusal of data in the referred table revealed that only 40% of the sample schools had more than 75%

of the required furniture in their biology laboratories, 33% had 50% to 75% and the remaining 27% had less than 50% of the specified furniture. It was shocking that 7% of the sample higher secondary schools had even less than 25% of the required furniture items and other relevant articles. In the absence of these provisions one easily imagined how much importance was being given by these schools to their practical activities in the teaching of biology.

5.2.3 Status of Science Laboratories in Colleges:

Sadly, the investigator could not repeat the same exercise for college level Science Education because the affiliating body i.e., Mizoram University did not make specifications as was done by the MBSE for school education. According to the University Ordinance[12], the University had made a number of stipulations for a college to be affiliated to it, in cluding those offering science as a subject. However, It was silent with regards to the various equipment needed to have a science laboratory that would adequately provide the needs of its students.

5.3 Practical Activities For the Teaching of Science at Different Levels of Education.

A major area of concern is the degeneration of rigour in experimental work in secondary and higher secondary schools. Yet science is a subject whose teaching cannot be completed by mere classroom lecture. It needs a dedicated effort that combines classroom teaching with demonstration and laboratory work that can stimulate the brain of students and encourage them to take bigger steps in the field of science. The checklist which had previously been circulated to sample secondary schools and higher secondary schools had revealed that schools were differently endowed when it came to practical facilities. But it is a known fact that even the most well equipped schools tend to give only cosmetic importance to laboratory work. This has resulted in schools producing students with much theoretical knowledge but very little practical knowledge about scientific phenomena.

[12] **OB – 6 ON THE AFFILIATION OF COLLEGES** Under Section 26 (1)(n) of the MZU Act,2000 (read with Clause (7) of Statute 31)

Before embarking on an endeavour to find out the amount of time schools give to practical work, the investigator found it necessary to pay a visit to the SCERT in order to find out whether they had given any advice or a master plan for the weekly routine of science in schools. Unexpectedly, the investigator was told that no such plan was made and that schools had to make their own time tables based on their own priorities.

5.3.1 Status of Practical Activities in Sample High Schools:

The following tables show the number of practical activities done by schools on a weekly basis besides a few other information:

Table-5.31shows that out of 25 secondary schools, 20 schools had laboratory for science practical work. The table also showed that none of the schools had a separate laboratory for physics, chemistry and biology. This could be because the MBSE has not been very strict in laying down the conditions for high schools and only stated separate rooms as desired and not as a condition for the school to be affiliated to it.

Table-5.31
Presence of Science Laboratories in Sample High Schools

Whether school has a Science laboratory				**Separate laboratory for physics, chemistry and biology**			
YES		**NO**		**YES**		**NO**	
N	%	N	%	N	%	N	%
20	80	5	20	0	0	25	100

Table-5.32
Number of Practical Classes held each week in Sample Higher SecondarySchools

No Practical Class		**One Practical Class Per Week**		**Two Practical Classes Per Week**		**Three Practical Classes Per Week**		**Four Practical Classes Per Week**	
N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
14	56	8	32	1	4	1	4	1	4

An incriminating fact that emerged out of the checklist was that out of the 25 schools, only 11(44%) of them could hold practical classes on a weekly basis.

Among these, 8(32%) of them could do so just once a week. As shown by the Table-5.32, only 1(4%) school could have 4 practical classes in a week and another could have it 3 times a week. The rest 14 of them could not do so even for a single class in a week. Among the schools that could devote their time to practical work on a weekly basis, And though this fact was not reflected in the present table, informal interaction with the science teachers revealed that most of these schools had their practical classes a few weeks before their external examinations so that students would not be so lost when their examination came. There were also a few schools that did not do any practical work at all. This was not a healthy result even in the absence of a clearly laid down timetable by the SCERT. Science education, unlike most other subjects, if not complimented by practical work becomes a heavy set of an abstract world coded in long texts and difficult language. More than any other subject, it needs a healthy balance of classroom lecture and laboratory work. Therefore the absence of a healthy balance between theory and practical was surely a negative picture of the status of science educaiton in the state.

Since the investigator had the opportunity to have face to face interaction with the science teachers, she took advantage to inquire about the supply of materials since another checklist had revealed a poor collection of laboratory apparatus in most of the schools. All the teachers and laboratory assistants complained that supply of science kits were irregular and that often, they had to make their requests to the Science Promotion Wing in order to get fresh supplies. Especially for the schools outside the city, another problem was that they had to go to the wing to fetch their supplies and this added to their yearly expenditures because no provision for that was made in the financial grants allotted to the schools.

Another fact that emerged out of the checklist was that there was still some disparity in the distribution of science teachers among different schools. While there were schools with more than 100 students taken care of by 2 or 3 science teachers, there were those that had the same number of students or more taken care of by a single science teacher. The MBSE clearly laid down that all the teachers of a High School shall be graduates with a Professionals Degree from a recognised University and at least two of them should be science graduates, one being capable of teaching either Mathematics or both. This meant that Mizoram, even after 24 years of becoming a full fledged state, still had high schools that operated in violation of the State Board of School Education.

Table-5.33
Student teacher ratio in sample high schools

Student teacher ratio	**Class VIII**		**ClassIX**		**Class X**	
	N	%	N	%	N	%
1:10 to 1:25	8/25	32	7/25	28	14/25	56
1:26 ti 1:40	5/25	20	10/25	40	5/25	20
1:41 to 1:55	4/25	16	3/25	12	4/25	16
1:56 to 1:70	4/25	16	1/25	4	1/25	4
1:71 and above	4/25	16	4/25	16	1/25	4

As seen in Table-5.33, the student teacher ratio in many of the sample high schools were not at all safe. At the Class VIII level, taking for granted that a ratio of upto 1:40 is within the desirable range, 52% of the sample schools fell within this range, but the rest 48% still survived on the undesirable side and in fact, 16% of the schools had a ratio of 1:70 which meant that a teacher took care of 70 students everyday. Class IX profile was slightly better oweing to the fact that the number of students had come down. In this case, it was also enough reason to feel alarmed because the fall in the number of students could be due to drop out or stagnation, both of which are a huge waste of human and financial energy. ClassX stage had the best profile because 76% of the sample schools fell within the desirable range. But in consideration of the crucial importance played by the high school stage, it was a wonder that so many schools were allowed to function with such unhealthy student teacher ratio.

The overall student teacher ratio also showed that there was a huge difference between Class VIII and Class X. While there was a ratio of 1:42 at the Class VIII level, which bordered on the undesirable, the ratio of 1:25 at the Class X level was well within thte desirable range. This disparity between classes is something that needs to be carefully looked into because no stage is more important than the other from the educational point of view.

5.3.2 Status of Practical Activities in Sample Higher Secondary Schools

The following tables show the status of practical activities in the sample higher secondary schools:

Table-5.34 indicates the status of laboratories in 15 sample higher secondary schools that were chosen from different parts of the state covering government, deficit and privately owned higher secondary schools. As shown in the table, 100% of the schools had a separate room for physics, chemistry and biology practical work. It may be noted that higher secondary stage is the stage where diversification of disciplines start. This could be the reason for the measure of independence each discipline seems to have from another discipline.

Table-5.34
Status of Science Laboratories in Sample Higher secondary Schools

Whether school has a Science laboratory				Separate laboratory for physics, chemistry and biology			
Yes		No		Yes		No	
N	%	N	%	N	%	N	%
15	100	0	0	15	100	0	0

Table-5.35
Status of Practical Classes Per Week in Sample Higher Secondary Schools

Less than 4 practical classes per week		4-6 Practical Class Per Week		7-9 Practical Classes Per Week		10-12 Practical Classes Per Week	
N	%	N	%	N	%	N	%
3	20	7	46	4	27	1	7

As evident in Table-5.35, except for 2(13%) schools that could perform practical work only once and twice in a week respectively, most of the schools (80%) could have practical classes at least 4 times in a week. This is a clear indicator that practical classes are taken more seriously at this stage. 1 school (7%) could even hold practical classes 12 times in a week. If this was the case, one could infer that when it came to practical works, higher secondary schools were quite active, especially in comparison to high schools.

As earlier stated in the high school section, the investigator could also glean a few pertinent facts that could not be reflected in the table. It was clearly stated by the teachers concerned themselves that even in this stage, practical work could not be given the priority it deserved due to lack of facilities. There were only a few experiments that students could perform on an individual basis. The rest had to be shared between 2 or more students and there were even some experiments where students had to be satisfied by a single demonstration.

Thus, higher secondary schools certainly performed better in terms of practical works and they showed a better status in comparison to high schools. But given the fact that higher secondary stage was the level where diversification of subjects into different streams began, this was only to be expected. In fact, the investigator found the difference less than desirable. But for higher secondary schools to perform better there has to be bigger input for teachers as well as laboratory equipment.

Table-5.36
Student Teacher Ratio in Sample Higher Secondary Schools

Student teacher ratio	**Physics**		**Chemistry**		**Biology**	
	N	%	N	%	N	%
1:1 to 1:9	3/15	20	3/15	20	3/15	20
1:10 to 1:25	7/15	47	7/15	47	10/15	67
1:26 to 1:40	5/15	33	5/15	33	2/15	13

The student teacher ratio of ClassXII level, as shown by Table-5.2.2.3 strongly indicated that the student teacher ratio in the sample higher secondary schools fell below the national average of 1:42(UNICEF 2004). But this was still much higher than the ideal situation of 1:20 as calculated by Western educationists. However, in the case of biology, 67% of the sample secondary schools were within the desired range of 1:25. Only 13% of the sample higher secondary schools were outside the desirable ratio. However, in the subjects of physics and chemistry, the student teacher ratio still remained at 1:33, when this study was undertaken.

Table-5.37
Overall student teacher ratio in higher secondary schools

Student teacher ratio	Physics	Chemistry	Biology
	1:20	1:20	1:16

The overall student teacher ratio, as shown by Table-5.37 clearly showed that the sample higher secondary schools had good student teacher ratio. It fell much below the national average. This meant that the teachers were able to devote more time to students. Infact, when compared to states like Uttar Pradesh and Bihar where the pupil teacher ratio is 1:83(UNICEF), this was good situation, especially for practical classes.

5.2.3 Status of Practical Activities in Colleges

The status of practical classes in colleges offering science education may be highlighted with the help of the following tables:

Table-5.38
Status of Science Laboratories in colleges offering science

Whether college has a Science laboratory				Separate laboratory for physics, chemistry and biology			
Yes		No		Yes		No	
N	%	N	%	N	%	N	%
6	100	0	0	6	100	0	0

A look table-5.38 indicates that science education at the college level had a sharply different characteristic when compared to school education including higher secondary school education. All the colleges had a separate laboratory for each subject. However, as seen by the researcher, most of them were not in the proper form as was expected of a college teaching science. In fact, many of the college laboratories were not pucca buildings and did not have the ideal equipment so as to foster a good understanding of scientific phenomena.

Table-5.39
Status of Practical Classes Per Week in colleges offering science

Less than 4 practical classes per week	4-6 Practical Class Per Week	7-9 Practical Classes Per Week	10-12 Practical Classes Per Week

N	%	N	%	N	%	N	%
0	0	5	83%	0	0	1	17

As revealed in Table-5.39, although 83% of the colleges could hold more than four practical classes in a week, it was still shown that 17% of them could have more than ten practical classes in a week. It was obvious that there still existed some disparity between young colleges and the older ones located in the capital. The positive side of this is that, unlike higher secondary and secondary schools, there were no colleges that could not have at least one practical classes in a week. But since the data was a combinatin of honours and general courses, the investigator still felt that there was room for much improvement especially considering that science is a subject almost wholly centred on practical activities.

Table-5.40
Status of Laboratory Staff in colleges offering science

Presence of Laboratory Assistant											
In 5 subjects		In 4 subjects		In3 subjects		In 2 subjects		In 1 subject		nil	
N	%	N	%	N	%	N	%	N	%	N	%
0	0	1	17	0	0	0	0	2	33	3	50

Laboratories cannot function properly without the laboratory assistant for each subject who makes arrangement for scientific experiments and keeps a record of the various apparatus and equipment that the laboratory needs. When a laboratory does not have a proper laboratory assistant, all these works are left unattended and the laboratory cannot function like a complete body. The added problem is that the teachers themselves have to assist the assistant in turn. This has adverse effect on the quality of scientific experiment as much time is often wasted in making arrangements for each experiment.

A look at Table-5.40 clearly indicates that 50% of the colleges teaching science still functioned with no laboratory assistant in any of the subjects at the time the investigation was done. Only 17% of the colleges had a laboratory assistant for 4 subjects.

Table-5.41

Status of Laboratory Staff in colleges offering science

Presence of Laboratory Attendant											
In 5 subjects		**In 4 subjects**		**In 3 subjects**		**In 2 subjects**		**In 1 subject**		**nil**	
N	%	N	%	N	%	N	%	N	%	N	%
3	50	0	0	0	0	2	33	1	17	0	0

As revealed in Table-5.41, the status of college laboratories in terms of presense of laboratory attendants was also weak. The laboratory attendant or the laboratory bearer is the one who actually gets the laboratory ready for the day. He or she has to see that there is sufficient equipment and also ensures proper planning for each experiment. But as seen in the table, although there was no college that did not have at least one in place, only 50% of the colleges had one laboratory attendant for each subject and 17% of the colleges still had to function with just one laboratory attendant.

Colleges are under the care of Higher and Technical Education in Mizoram in terms of financial aid. Except for Pachhunga University College which is a constituent college of Mizoram University, the main financial allocations are made through this body although there are special funds that come directly from the University Grants Commission. As such this Directorate implements various programmes aimed at improving higher education. One such duty is to give information with regards to the eligibility of a college to be provincialised. One such stipulation is that the college should have adequate qualified teaching staff and non-teaching staff to be appointed on a regular basis. Being the affiliating body, Mizoram University has also clearly asserted the need for adequate teaching staff if a college is to be affiliated to it. In fact, the University ordinance has clearly spelled the minimum staffing requirement as at least five teachers for an honours course in science and for teachers for a three year degree course in general science. During the time this study was conducted, only the two colleges located in the capital city of Mizoram and Lunglei College could meet the minimum requirement laid down by the affiliating university. But so far, most of the colleges still seem to be in need of part time teachers as well as teachers on contract basis in order to fulfill the minimum requirement. As there is no security in these kinds of posts, there is always a threat that the college may suddenly be left with inadequate teachers since the temporary teachers are free to look for other means of employment if the government cannot guarantee a permanent position for them.

Table-5.42
Student teacher ratio in colleges

Student teacher ratio	**1st year**		**2nd year**		**3rd year**	
	N	%	N	%	N	%
1:0 to 1:5	4/6	67	5/6	83	5/6	83
1:6 to 1:10	1/6	17	1/6	17	1/6	17
1:11 to1:15	-	-	-	-	-	-
1:16 to 1:20	1/6	16	-	-	-	-

As per new regulations of the UGC, the student teacher ratio should be one for every 25 students at the undergraduate level. As shown by the Table-5.42, the first, second and third year students showed a ratio of less than 1:10, with only the first year batch surpassing the norm of 1:10. Although this looked like a good profile, it could not really be accepted as good when studied from the economic point of view. Some colleges even had almost the same number of students and teachers. With the infrastructure needed for the setting of laboratories, its equipment and the human resources need, a ratio of less than 1: 20 meant that science education certainly gave small returns in consideration of the labour given to it.

Table-5.43
Overall student teacher ratio in college

Student teacher ratio	**1st year**	**2nd year**	**3rd year**
	1:6	1:2	1:2

As would be expected, the student teacher ratio at the college level was barely 1:6, as seen in Table-5.43. According to the ordinance maintained by the affiliating body,under Section 26 (1) of the MZU Act 2000, colleges that had a three year degree course in general science need to have at least four teachers for each subject and five teachers for each subject in th ehonours course. This meant that during the time this study was done, science education was still a very expensive endeavour with only a handful of students under the care of four or five teachers, depending on the type of the course. Such a situation was not at all desired given the need for the state to produce more science graduates to take care of science education at the school level and to increase enrolment at the post graduate level.

5.4 Critical Analysis of time table at various levels of Science Education

Time table, the main document that acts as a guideline for educational institutions world over is one of the most important element when studying the status of educational systems. In the present study, time tables of sample schools from HSLC, HSSLC and college were taken to analyse the amount of time devoted to theory and practical education.

In Mizoram, the basic knowledge of Science, including Physics, Chemistry, Biology and Mathematics is compulsory for every student till 10th grade.

After class 10th, a student may choose any of the available streams. In class 11th and 12th, those who take science, learn the basics of Applied Physics, Applied Chemistry, Plant and Animal Biology and/or Higher Math. After completion of Class 12, one can either take the conventional way i.e. do courses such as B.Sc and M.Sc (or can opt for a professional career such as B.Tech and MBBS outside the state).

Based on the subjects offered, a curriculum is prepared and the time table is designed for each class in order to realize the goals of the curriculum. Although the MBSE has not prepared a model time table for schools at this level, nor has the affiliating University set the amount of time to be devoted to each subject at various levels, the investigator considered it important to thoroughly study the distribution of different subjects and analyse whether the real needs of students are met. The pertinent information with regards to the weekly distribution of classes at different levels of education from secondary to college level for the year 2010 has been shown in the following tables:

5.4.1 Analysis of Time Tables of High Schools:

A look at Table-5.44 revealed that during the time the investigation was done, it was found through the school time tables that the sample high schools seemed to take theory classes more seriously than practical classes. As far as theory classes were concerned, 4% of the sample high schools could give 12 theory classes in a week. A majority of 75% of the sample high schools could give 9 science theory classes in a week. Only 20% of the sample high schools could give a minimum 5 theory classes in a week. All these facts showed that theory classes were not neglected in the sample high schools.

Table-5.44
Allotment of Theory and Practical Classes in Class-X in Time Table in Sample High Secondary Schools (N=25)

No.of Classes Per Week	Theory		Practical	
	N	%	N	%
12	1	4	-	
9	3	75	-	
8	2	8	-	
7	14	56	-	
6	5	20	-	
2	-		1	4

As far as the practical classes were concerned, only 4% of the sample high schools could have 2 practical classes in a week. The rest 96% of the sample high schools did not make allotment for practical classes in their time table.

5.4.2 Analysis of Time Tables of Higher Secondary Schools

Table No-5.45
Allotment of Theory and Practical Classes in Class-XI in Time Table in Sample Higher Secondary Schools (N=15)

No.of	Theory Subject	Practical	Remarks

Classes Per Week	Physics	Chemistry	Biology	Physics	Chemistry	Biology	
8 & Above	3(20%)	2(13%)	3(20%)	-	-	-	20% of the sample schools allotted 4 classes for practical classes in a week without specifying the subject.
7	4(27%)	2(13%)	2(13%)	-	-	-	
6	6(40%)	3(20%)	3(20%)	-	-	-	
5	5(33%)	6(40%)	5(33%)	-	-	-	
7	4(27%)	2(13%)	2(13%)	-	-	-	
6	6(40%)	3(20%)	3(20%)	-	-	-	
5	5(33%)	6(40%)	5(33%)	-	-	-	
4	3(20%)	2(13%)	2(13%)	-	-	-	
2	-	-	-	7(47%)	7(47%)	7(47%)	
Nil							

As revealed in Table-5.45, the XI level science was still much dominated by theory classes. At the time the investigation was done, the sample schools showed the following results based on their time table:

- For physics, 20% of the sample higher secondary schools could have 8 or more theory classes in a week. It was seen that 40% of the sample higher secondary schools could have 6 theory classes in a week. But the data clearly showed that 20% of the sample higher secondary schools could have only 4 classes in a week.
- For chemistry classes, it was seen that 13% of the sample higher secondary schools could have 8 or more theory classes in a week. At the same time, it was also seen that another 13% of the sample higher secondary schools could have only 4 theory classes in a week.
- In biology, the sample higher secondary schools exhibited almost the same trend that was found in other science subjects. While 20% of the sample higher secondary schools could have 8 or more theory classes in a week, 13% of the sample higher secondary schools could not have more than 4 theory classes in a week.
- As far as practical classes were concerned, 47% of the sample higher secondary schools showed that they could have 2 practical classes in a week. At the same time, it was also seen that 20% of the sample higher secondary schools set aside 4 classes for practical classes in a week without specifying the subject whose

practical work would be taken up. The rest of the sample higher secondary schools did not show any place for practical work as shown by the time table.

Table-5.46
Allotment of Theory and Practical Classes in Class-XII in Time Table in Sample Higher Secondary Schools (N=15)

No.of Classes Per Week	Theory Subject			Practical		
	Physics	Chemistry	Biology	Physics	Chemistry	Biology
8 & Above	3 (20%)	3(20%)	2(13%)	-	-	-
7	4(27%)	3(20%)	2(13%)	-	-	-
6	2(13%)	3(20%)	4(27%)	-	-	-
5	4(27%)	4(27%)	4(27%)	-	-	-
4	2(13%)	2(13%)	3(20%)	-	-	1(6%)
2	-	-	-	8(53%)	8(53%)	7(47%)
Nil				7(47%)	7(47%)	7(47%)

A look at Table-5.46 showed clearly that at the class XII level, theory classes still occupied a much bigger place in the time table when compared with practical work. A look at each subject revealed the following facts:

- For physics, only 20% of the sample higher secondary schools had 3 theory classes in a week. It was also seen that 13% each, of the sample higher secondary schools could have 6 and 4 theory classes in a week. At the same time the data also showed that 27% each, of the sample higher secondary schools could have 7 and 5 theory classes in a week.
- For the practical classes, it was shown that out of the sample higher secondary schools, only 53% of them could have at least 2 practical classes in a week. The rest 53% did not show any allotment for physics in their time table.
- In chemistry, the sample higher secondary schools showed that 20% each, had 8 or more, 7 and 6 theory classes respectively, in a week. It was also seen that 27% of the sample higher secondary schools could have 5 theory classes in a week. But 13% of the sample higher secondary schools could have only 4 theory classes in a week.

- For the practical classes, it was seen that 53% of the sample higher secondary schools could give 2 practical classes in a week, But even here, the rest 47% of the sample higher secondary schools could not give any practical work as indicated by their time table.
- In biology, 13% each, of the sample higher secondary schools could give 8 or more and 7 theory classes in a week. It was also seen that 23% each, of the sample higher secondary schools could have 5 and 6 practical classes in a week. But even in this subject, 20% of the sample higher secondary schools still showed that they could not give more than 4 theory classes in a week.
- A look at the practical classes for biology revealed that unlike the other sciences, 6% of the sample higher secondary schools could give 4 practical classes in a week and this was because in these schools Biology was divided into Zoology and Botany and practical classes were thus given separately. The data also showed that 47% of the sample higher secondary schools could have 2 practical classes in a week but sadly, an equal percentage showed that they could not have any practical classes as was indicated by their time table.

5.4.3 Analysis of Time Tables of Colleges:

5.4.3.1 Time Tables of Colleges: A Macro Analysis:

As indicated by Table-5.47, during the time this investigation was done, the overall distribution of theory and practical class in colleges teaching science was not good. Practical classes took very little space by looking at the time table. A look at the honours course reveal that from the first to the third year, theory classes took an average of 72% of the total classes in a week. Although science is a subject based on practical work, the colleges of Mizoram teaching science still devoted themselves more on theory classes rather than to practical classes. Science Education plays an important role in creating scientific temper and generating wealth through science-based technologies. But its role is accomplished only when it is accompanied by well developed practical work. Therefore, the fact that there still existed such a wide gap between theory and practical work was a clear indicator that the state was still very much in lack of a proper science education system even at the college level.

Table-5.47
Weightage Given to Theory and Practical Classes in General and Honours Courses at College Level

Year	Honours		General	
	Weightage to Theory Classes (%)	Practical %	Weightage to Theory Classes (%)	Practical(%)
1st Year	72	28	75	25
2nd Year	74	26	71	29
3rd Year	71	29	75	25

Unexpectedly, general course time table did not vary much from honours course time table, as indicated by Table-5.47, 73% of the entire classes in a week was taken up by theory classes. This showed that practical classes were given only a minor importance in general course.

5.4.3.2 Time Tables of Colleges: A Micro Analysis:

Developed countries in spite of being very successful in science and technology keep on working at making science education more attractive for young people so that their citizens maintain interest and curiosity about the world they live in, and also to meet the future challenges in health, energy, global warming and many other critical areas. The macro analysis of the college time tables had revealed that throughout the three years of under-graduate science education, practical education had taken up less than 30% in the time tables. The following is a micro analysis of time tables of the colleges offering science subject which indicates the real situation of science education at the college level during the time this study was done.

Table-5.48
Time Table for 1st Year B.Sc(Honours)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemisty		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	6	4	6	4	6	4	6	4	6	4	NA	NA	**30 (60)**	**20 (40)**
Zirtiri Residential Science College	6	2	6	2	6	2	6	2	NA	NA	6	2	**30 (75)**	**10 (25)**
Lunglei Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**

Champhai Gov't. College	10	2	10	2	10	2	NA	NA	NA	NA	NA	NA	**30 (83)**	**6 (17)**
Kolasib Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Serchhip Gov't. College	5	2	5	2	5	2	5	2	NA	NA	NA	NA	**20 (71)**	**8 (29)**

**No honours course in Champhai Gov't. College*

As shown by Table-5.48, except for Pachhunga University College, which devoted 60% to theory classes and 40% to practical classes, all the colleges that offered science subject gave less than 30% of the classes for practical works. The least time devoted to practical work was by Champhai Gov't. College which only gave 17% of the classes to practical works as shown by their time table. Only Pachhunga University College and Zirtiri Residential Science College offered honours courses in 5 subjects. The rest of the colleges offered honours courses for 4 subjects except for Champhai Gov't College which did not have affiliation for honours course in zoology.

Table-5.49

Time Table for 1st Year B.Sc(General)

Name of the college	**Physis**		**Chemisy**		**Botany**		**Zoology**		**Geology**		**Biochemistry**		**TOTAL %**	
	T	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**
Pachhunga University College	6	2	6	2	6	2	6	2	3	2	NA	NA	**27 (73)**	**10 (27)**
Zirtiri Residential Science College	7	2	6	2	6	2	7	2	NA	NA	6	2	**32 (76)**	**10 (24)**
Lunglei Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Champhai Gov't. College	7	2	7	2	7	2	7	2	NA	NA	NA	NA	**28 (78)**	**8 (22)**
Kolasib Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Serchhip Gov't. College	5	2	5	2	5	2	5	2	NA	NA	NA	NA	**20 (71)**	**8 (29)**

A look at the Table-5.49 clearly showed that there was not much difference in terms of class distribution when comparing honours and general courses. The table showed that 100% of the colleges offering science courses devoted more than 70% of their time to theory classes as shown by their time table. None of the colleges gave more than 30% to practical work.

Table-5.50
Time Table for 2nd Year B.Sc(Honours)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemistry		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	5	2	5	2	5	2	5	2	5	2	NA	NA	25 (71)	10 (29)
Zirtiri Residential Science College	5	2	5	2	5	2	5	2	NA	NA	5	2	25 (71)	10 (29)
Lunglei Gov't. College	5	2	5	2	5	2	5	2	NA	NA	NA	NA	20 (71)	8 (29)
Champhai Gov't. College	10	2	10	2	10	2	10	2	NA	NA	NA	NA	40 (83)	8 (17)
Kolasib Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	24 (75)	8 (25)
Serchhip Gov't. College	6	2	5	2	5	2	5	2	NA	NA	NA	NA	21 (75)	8 (25)

An analysis of theory and practical classes in 2nd year B.Sc honours course in Table-5.50 was seen here. Not surprisingly, a similar pattern previously witnessed in the 1st year B.Sc time table was seen . The maximum time is devoted to theory classes in all the colleges involved. The classes devoted to theory classes ranged from 71% to 83% of the total classes in a week. On the other hand, the classes devoted to practical works ranged between 17% to 29% of the total number of classes in a week as shown by their time tables.

Table-5.51
Time Table for 2nd Year B.Sc(General)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemistry		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	7	2	7	2	7	2	7	2	3	2	NA	NA	31 (76)	10 (24)
Zirtiri Residential Science College	9	4	9	2	9	2	9	2	NA	NA	9	2	45 (82)	10 (18)
Lunglei Gov't. College	8	2	8	2	8	2	8	2	NA	NA	NA	NA	32 (80)	8 (20)
Champhai Gov't. College	9	2	8	2	8	2	9	2	NA	NA	NA	NA	34 (81)	8 (19)
Kolasib Gov't. College	9	2	6	2	7	2	8	2	NA	NA	NA	NA	30 (79)	8 (21)

Serchhip Gov't. College	5	2	5	2	5	2	5	2	NA	NA	NA	NA	**20 (71)**	**8 (29)**

Table-5.51 shows the distribution of practical and theory classes in 2nd year B.Sc. Here again, there was not much variation between colleges and not much difference was found when compared with class distribution for honours course. The data showed that 50% of the colleges that offered science course devoted more than 80% of the total number of classes to theory classes. Much less time was given to practical works. Serchhip Gov't college was the college that gave maximum priority to practical work by setting aside 29% of the total number of clases to practical work.

Table-5.52

Time Table for 3rd Year B.Sc (Hons)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemistry		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	8	4	8	4	8	4	8	4	3	4	NA	NA	**35 (64)**	**20 (36)**
Zirtiri Residential Science College	9	2	9	2	9	2	9	2	NA	NA	9	2	**45 (82)**	**10 (18)**
Lunglei Gov't. College	9	2	9	2	9	2	9	2	NA	NA	NA	NA	**36 (82)**	**8 (18)**
Champhai Gov't. College	9	2	9	2	9	2	9	2	NA	NA	NA	NA	**36 (82)**	**8 (18)**
Kolasib Gov't. College	10	2	10	2	10	2	10	2	NA	NA	NA	NA	**40 (83)**	**8 (27)**
Serchhip Gov't. College	3	2	5	2	4	2	4	2	NA	NA	NA	NA	**20 (71)**	**8 (29)**

As indicated by Table-5.52, three of the colleges, namely Zirtiri Residential Science College, Lunglei Gov't. College and Champhai Gov't. College showed dismal performance in terms of class distribution between theory and practical classes by giving only 18% of the total classes to practical works. Pachhunga University College showed the best profile by devoting 36% of the total classes to practical work. Serchhip Gov't. College also did quite well in comparison to the other colleges by giving 29% of the total classes to practical work. However, considering that it was the final stage of honours course in question, it was disappointing to find that not much difference was found between the theory and laboratory work.

Table-5.53
Time Table for 3rd Year B.Sc (General)

Name of the college	Physics		Chemistry		Botany		Zoology		Geology		Biochemisty		TOTAL %	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P
Pachhunga University College	5	2	4	2	6	2	5	2	3	2	NA	NA	**23 (70)**	**10 (30)**
Zirtiri Residential Science College	8	2	7	2	5	2	8	2	NA	NA	5	2	**32 (76)**	**10 (24)**
Lunglei Gov't. College	5	2	7	2	5	2	6	2	NA	NA	NA	NA	**23 (74)**	**8 (26)**
Champhai Gov't. College	9	2	8	2	6	2	9	2	NA	NA	NA	NA	**32 (80)**	**8 (20)**
Kolasib Gov't. College	6	2	6	2	6	2	6	2	NA	NA	NA	NA	**24 (75)**	**8 (25)**
Serchhip Gov't. College	4	2	5	2	5	2	5	2	NA	NA	NA	NA	**19 (70)**	**8 (30)**

Table-5.53 highlights the distribution of theory and practical work for general course in the 3rd year B.Sc. Although this was a general course, it was refreshing to find that two of the colleges namely Pachhunga University College and Serchhip Gov't. College gave 30% of the total number of classes to practical work. The rest of the colleges gave not more than 26% of the total classes to practical work. Besides this, not much difference was found between honours and general courses.

5.5 Conclusion:

Science cannot be fully understood and appreciated without a thorough understanding of scientific principles which can only happen when it is done practically. Although practical work may be a bit more expensive than theory classes, it is an endeavour worth investing in because it is the only way with which students will be able to understand the true importance of science in their everyday life. As shown by the time tables of the six colleges offering science education, there was a huge gap between theory and practical classes. This was not a healthy picture as it indicated that science education in Mizoram was still concentrating on the theory part rather than on the practical part. If the state truly desires to bring up citizens that would be in a position to take the state and the country to further progress in technological development, than a strong reconsideration of its science syllabus is a must.

As shown by the checklist which was meant to find out information with regards to the status of practical classes, it was clear that secondary schools and higher secondary schools are far from satisfactory in maintaining adequate laboratories for science education. This could be due to lack of interest in the practical side of science education. But most of these schools reported that they did not receive the required amount of equipment from Science Promotion Wing. The little amount of apparatus and equipment they had were those bought by the schools. This, as the investigator found out, was the main reason behind the wide disparity that existed among schools in the urban area and in the rural areas. While most of the schools in the urban areas had students with parents who could help out in the equipment of school laboratories with good equipment, those in the rural areas did not have the support of their parents who were mostly daily wagers. As such, equal distribution of laboratory facilities was not found. On the other hand, since all schools were expected to receive equipment from the Science Promotion Wing, it was disheartening to find certain schools that did not even have the bare minimum for their science laboratories. In fact, many of the so called laboratories were store rooms converted as makeshift laboratories. Hardly any school could meet the requirement made by the MBSE. However, as their rules and guidelines had the accompanying foot note that in special cases, relaxation will be made, these schools still exist. The investigator found that many of the schools just managed to survive because of the last provision On the other hand, if these schools were closed, there would be no other alternative for the students except private schools. Since private schools are expensive, most parents, especially in the rural areas will not be able to send their children for school. The result will be total chaos. But if the present situation is allowed to continue, the serious fall in quality will adversely affect the other levels of education as well as the society at large. The investigator, upon finding this result also concluded that this could be the reason for the gradual decline of practical work and experimentation at secondary schools and higher secondary schools.

It was sad to find even colleges falling so far behind expectations. As could be interpreted from the above analysis, if one may mark Aizawl as urban and the rest as rural, it could be safely assumed that there was a wide gap between urban colleges and rural colleges.

Another fact that emerged out of the analysis of theory and practical work based on the Checklist and the institutional time tables clearly showed that there was a disparity in between the two. This clearly indicated that schools and colleges did not exactly go by the time tables, one trend that is not condusive to proper science education. Therefore, the investigator was disappointed to find science education in such poor condition. Science education, unlike other stream has a direct impact on the living standard of society. Therefore, the state government may be wise to invest more in this sector. At the same time, the college authorities and teachers as well as students all have the duty to see that science education is allowed to develop in full bloom.

CHAPTER-VII

DEVELOPMENT OF HUMAN RESOURCES IN SCIENCE IN MIZORAM

7.0 Introduction:

Science and technology are the drivers of economic growth and science education forms the backbone of all science and technology efforts in any country. Today it is being increasingly realised that the only way to improve the nation's competitiveness is through better science and technical education. After more than 60 years of independence, India too, is deep into the competition for excellence in science and technology. However, recent concerns about falling enrolment in science at higher secondary level and undergraduate level have raised the concern of various interested bodies. This has given rise to a number of commissions and surveys with the objective of finding out the real situation in science education. The Human Development Report 2004 indicated that *only 25 percent of all students enrolled in tertiary institutions are studying math, science and engineering programme* [13]within the country.

However, to contradict the dismal picture, the National Science Survey–2004 has found that *concerns about falling science enrolment in the country are misplaced, on the contrary annual enrolment of those studying science has risen. But the lower follow-through to higher levels, particularly doctorates, could lead to a critical shortage of technically qualified teachers. At the school level too there is ample scope for improvement in science education as far as teaching*

[13] ***Human Development Report 2004***. United Nations Development Programme (UNDP)

methods, provision of scientific equipment, and contemporariness of syllabi is concerned[14].

7.1 Development of Human Resources in Science: A National Scenario

A number of efforts at the national level have been made in order to make Science Education available to all. Due to this, enrolment has risen both at the higher secondary level as well as higher education. A look at Tables-7.1 and 7.2 clearly reveals the enrolment status for science education as compared to other fields of education at the all India level

Table- 7.1

Enrolment for Examination at Higher Secondary Level of Various Fields under CBSE (2000-2002)

Year	Economics	Mathematics	Physics	Chemistry	Biology	Accounts	TT
2000	127,640	122,242	112,306	112,216	62,182	82,471	619,057
2001	133,772	138,891	125,183	125,797	64,497	87,085	675,225
2002	145,710	160,861	147,941	147,236	69,069	93,914	764,731

Source: CBSE for India Science Report 2004

As seen in Table-7.1, when compared to Economics, a popular Arts subject that does not involve practical work, the enrolment in science subjects was quite low in the year 2000. However, the data clearly indicates a shift in the direction of science subject by the year 2002. Although the numbers of students in economics have risen, this is a small margin compared to the increase in enrolment for science subject. Not only is the rise in enrolment rate higher, the number of students itself became much more in all the science subjects except for

[14] **Shukla, R. et.al (2005).** India Science report: Science Education, Human Resources and Public Attitude towards Science and Technology. National Council of Applied Economic Research 2005. Parisila Bhawan, 11, Indraprastha Estate, New Delhi 110 002.

Biology. This is a good trend because the fact that enrolment rate has become higher means that students are becoming aware of the needs of the country. Not only this, it also indicates that more opportunities for enrolment is science has been opened by the educational system. All these can be interpreted as truly positive changes.

At the national level, as shown by Table-7.2, the 2007 record of the Ministry of Human Resources Development showing the enrolment in various fields still shows that maximum number of students at the under graduate level opt for Arts. When compared with enrolment in science, it is apparent that more than twice the number of enrolment in science is found for Arts. Another discouraging fact that Table-7.2 carries is that the number of boys enrolling themselves for science is nearly double the number of girls who have enrolled themselves in science at the under graduate level.

Table-7.2

Enrolment by Stages in Various Fields in Higher Education: India
(2004-2005)

Sl.No.	Educational Degree stage	Boys	Girls	Total
1.	Ph.D/D.Sc./D.Phill	32526	22826	55352
2.	M.A	250546	218745	469291
3.	M.Sc	107841	90878	198719
4.	M.Com	80616	41641	122257
5.	B.A./B.A.Hons.	2117637	1654579	3772216
6.	B.Sc./B.ScHons.	910440	580345	1490785
7.	B.Com/B.Com Hons.	928181	536847	1465028
8.	B.E/B.ScEngg/B.Arch	531207	165402	696609
9.	Medicine/Dentistry/Pharmacy /Nursing/Aurvedic/Homeopathy	167696	89052	256748
10.	B.Ed/B.T	87143	68049	155192
11.	Others*	1921887	1173212	3095099

Others include data of Open & Distance Learning Institutions.

Source: Selected Educational Statistics 2004-05, MHRD2007

7.2 Development of Human Resources in Science: Mizoram Scenario

Apart from what can be seen as the national trend where Science Education is concerned, at the state level, Mizoram has been actively promoting science, from the elementary to the higher levels of education. From its inception in 1985, the Mizoram Council of Science, Technology and Environment has been initiating a number of projects in order to promote science. Some of these are:

1) Post Matric Merit Science Scholarship programme (1988 till date)
2) Research Fellowship for Science and Technology (2009 till date)
3) Publication of Scientific journals
4) Participation in National Level Children Science Congress
5) Science and Technology Expo
6) Scientific Seminars.
7) DNA clubs in 20 schools for creating awareness on National Resources among school children
8) Development of a Science Centre in 2003.

Some of the above programmes were implemented in collaboration with bodies like STAM, MIPOGRASS and MSS. Thus Mizoram has been quite active in creation of incentive in science. However, the impact of all these programmes can only be understood by looking at how the state has been able to provide man power needs in science. For this, a look at the enrolment rate in science as well as the results obtained by science students is necessary. This is because these are the two mirrors that truly reflect any change that has taken place.

7.2.1 Enrolment at various levels of science education:

Enrolment is of primary importance in an attempt to trace the development of human resources in science. This is not only because it tells the number of students who have enrolled themselves in the subject but also because:

- Changing enrolment of students in science through the years is a revelation of the opportunities that have opened in science education,
- The change in enrolment in science education as one peruses the different levels of education can indicate whether science education has been able to sustain students’ interest, and

- The percentage of students who have enrolled themselves in science at different levels of education reveals the priority of the society, state and nation .

With these thoughts uppermost in mind, the following tables have been prepared so as provide the best possible information regarding enrolment of students at various levels of formal education.

(a) Enrolment at HSLC Level:

HSLC is considered as one of the most important milestones in the educational ladder for the Mizos. For some, it indicates a stepping stone for further education but for others it may be the end of formal education. In any case, the examination is considered as most important especially because it is also seen as the end of childhood by most mizo parents. This fact justifies the reason why enrolment at this level has been included while trying to understand the development of science education within the state, inspite of the absense of separate disciplines at this level. Moreover, the enrolment at this level provides the researcher with the required knowledge to understand more about the developmental trend of science education.

Table-7.3
Enrolment in HSLC

Year	Male		Female		Total
	N	%	N	%	
2000	5683	49	6019	51	11702
2001	5779	46	6785	54	12564
2002	5639	49	5964	51	11603
2003	5777	48	6195	52	11972
2004	6206	48	6618	52	12824
2005	5651	44	5879	56	11530
2006	6596	49	6656	51	13252
2007	6841	49	6994	51	13835
2008	6939	50	6926	50	13865
2009	7751	50	7716	50	15467
2010	7038	49	7161	51	14199

Source: Statistical Cell; Directorate of School Education; G.O.M.

The Table- 7.3 indicates the number of students enrolled for HSLC examinations as recorded by the Statistics Cell, Directorate of School Education, Government of Mizoram. It should be noted that at this stage, there is no division of students into different streams and all of them study a common set of subjects pre determined by the Mizoram Board of School Education. Due to this, it is not possible to understand the performance of students in science based on this data alone.

As indicated by Table-7.3, the number of female students is continuously more than the number of male students. This is a good trend because, looking at international trends, the most advanced countries are the ones that show a high level of female education. The fact that enrolment of boys in comparison to girls at the national level was so high had been a source of worry. With this in mind, the investigator concluded that by showing a healthy balance of male and female enrolment ratio, the young state has the potential to stand out as one of the most well turned out states in India.

(b) Enrolment at HSSLC Level:

Higher Secondary Education spells the beginning of choices for students climbing the academic ladder. At this stage, education is divided into various streams and the choice of students is clearly seen by looking at the enrolment in different subjects. Therefore, enrolment at this level plays a significant role in predicting the future of the state.

Table-7.4

Enrolment in Different Academic Streams in Class-XI

(2004- 2010)

Year	Arts		Commerce		Science		Total
	N	%	N	%	N	%	
2004	3585	75	303	6	896	19	**4784**
2005	Data not available						
2006	3506	70	291	6	1195	24	**4992**
2007	4137	71	344	6	1369	23	**5850**
2008	5204	71	426	12	1668	17	**7298**
2009	5440	70	602	**8**	1708	22	**7750**
2010	6635	73	706	8	1785	19	**9126**

Source: Statistical Cell; DSE., G.O.M.

It is difficult to trace the number of students who opted for technical studies since they are not all recorded by the Directorate of Higher and Technical Education. However, even by taking into consideration the possiblity of drift- outs at this stage, the investigator could see a huge decline in enrolment when comparing HSLC and Class XI in terms of enrolment. On top of this, it was evident based on existing records that science students were far less in number when compared with Arts students. However, there were also a number of positive things to be found. Enrolment in science stream saw a steady increase each year. Besides this, when considering the enrolment as a whole, the table clearly showed that the percentage of science students was not so small. Based on the evidence shown by Table-7.4, there was no steady rise in percentage while there was a steady rise in number. This was mainly because the number of students was increasing as a whole. All these indicate that more number of students have begun to choose science.

Table-7.5

Enrolment in Different Academic Streams in Class-XI I

(2004- 2010)

Year	Arts		Commerce		Science		Total
	N	%	N	%	N	%	N
2004	4309	79	282	5	904	16	**5495**
2005	Data not available						
2006	4829	77	270	5	1131	18	**6230**
2007	4767	73	268	4	1471	23	**6506**
2008	4705	69	394	6	1665	25	**6764**
2009	5722	71	567	7	1769	22	**8058**
2010	5899	70	720	8	1806	21	**8425**

Source: Statistical Cell; Directorate of School Education; G.O.M.

Table-7.5 shows that there was an increase in the number of students who have enrolled themselves for Class XII. However, there was clear evidence that enrolment in arts outnumbered that of science throughout the period covered by the study. This dominance is not very healthy when considering the overall development status of the state in general because as has been indicated by studies on development, science education plays a vital part.

On the other hand, the situation is not entirely negative because it also clearly shows the rise in the number of students in general and more importantly, the percentage of students who have enrolled themselves in science when calculated against the total enrolment shows a steady increase. This clearly indicates the growing popularity of Science Education at higher Secondary level within the state.

(c) Enrolment at College Level:

College is the beginning of higher education in India. At this stage, students are considered as adults and their choices are also respected. Studies have shown that in many cases, students who have completed their plus two education in science opt for Arts, professional studies or some other seemingly easier subject at the college level. Moreover, the enrolment in Honours and General or Pass courses reveal different facts. That is why an independent study of both Honours and Pass courses is needed. For this reason, the investigator has made an attempt to analyse the enrolment in these two courses separately.

Table-7.6

Enrolment in Honours Courses in Science in all Colleges with Science Stream

Year	2004-2005		2005-2006		2006-2007		2007-2008		2008-2009		2009-2010	
	TT	%	TT	%	TT	%	TT	%	TT	%	TT	%
PUC	148	75.1	238	49.3	380	53.9	509	58.8	456	56.3	307	49.3
Lunglei	13	6.5	38	7.9	43	6.1	65	7.5	57	7.1	43	6.9
Zirtiri	*	*	156	32.3	215	30.5	221	25.5	236	29.1	228	36.7
Champhai	7	3.7	7	1.4	14	2.0	17	2.0	23	2.8	16	2.6
Kolasib	25	12.7	29	6.00	32	4.5	35	4.1	23	2.8	17	2.7
Serchhip	4	2.0	15	3.1	21	3.0	18	2.1	15	1.9	11	1.8
TOTAL	197		483		705		865		810		622	

Sources:i) Mizoram University; Annual reports ii) Individual colleges

Data not available

At the College level, the young state shows a marked decline in the enrolment of students in science(Honours). A look at Table-7.6 clearly reveals the dominance of two colleges over the other four colleges in terms of student enrolment. The two colleges, namely Pachhunga University College and Zirtiri Residential Science College both continuously had more than 70% to 80% of the whole students enrolled in science courses. Especially in the case of Pachhunga University College, a look at all the six years revealed that it continuously captured more than 49% of the total enrolment in science. Zirtiri Residential Science College also continuously had more than 25% of the total enrolment in science. These two colleges have an advantage over the other colleges in being located in Aizawl city, the capital of the state.

Table-7.7

Enrolment in General Courses in Science in all Colleges with Science Stream

Year	2004-2005		2005-2006		2006-2007		2007-2008		2008-2009		2009-2010	
	TT	%	TT	%	TT	%	TT	%	TT	%	TT	%
PUC	10	71.4	32	71.1	12	38.7	35	49.3	15	10.9	36	50
Lunglei	-	-	3	6.7	4	12.5	-	-	-	-	4	5.6

Zirtiri	-	-	6	13.3	10	32.3	9	12.7	117	84.8	13	4.2
Champhai	2	14.3	1	2.2	-	-	19	26.8	-	-	16	22.2
Kolasib	2	14.3	-	-	1	3.2	3	4.2	3	2.2	3	4.2
Serchhip	-	-	3	6.7	4	12.5	5	7	3	2.2	-	-
TOTAL	**14**		**45**		**31**		**71**		**138**		**72**	

Sources: i) Mizoram University: Annual reports ii) Individual colleges.

Although enrolment in Honours course reveals a lot, the story is complete only after looking at the enrolment in Pass course or General Course in science. Table-7.7 indicates that at the time the investigation was done, there were only a few students enrolled under the general course in science stream. Especially when compared with honours course, the general stream students were only a small percentage. Moreover, it was enlightening to note that there were colleges where students were not enrolled in the general stream for certain years, thus the empty cells in the table under discussion.

This is a good trend because, according to the objectives of higher education as laid down by the Radhakrishnan Commission, higher education should strive to bring up students who would become useful citizens of the nation. General stream students have no chance to go for higher studies unless they are lucky to get admission in some training colleges or institutions. Therefore, the fact that students enrolled under general stream were far less in number is a good sign showing that students have vision and are willing to work harder for a better future.

Table-7.8

Enrolment in Science against Total Enrolment at College Level

Year	Total Enrolment	Enrolment in Science	% of Science Students
02-03	-	349	-
03-04	-	143	-
04-05	5462	197	3.60
05-06	8279	483	5.83

06-07	7486	705	9.41
07-08	7547	865	11.46
08-09	8836	810	9.16
09-10	9406	622	6.61

Sources: i) Mizoram University: Annual reports ii) Individual colleges.

It was not possible to get the complete data for all the colleges offering science, but there was enough to tell the scholar some important facts about science education. The total enrolment shown in Table-7.8 included the students from mainstream colleges, and all other institutions of higher education in Mizoram including professional institutions. The same table clearly indicates that the number of science students have been growing in the last five years, especially after the year 2005-2006. On the other hand, the total number of college enrolment has also been increasing. Taking this increase into consideration, the growth in science education has been minimal. It was only during the 2007-2008 academic session that enrolment in science stream at the college level rose to 11.46%. This, in comparison to the larger picture is still a small percentage. Especially in consideration of the fact that need for science graduates in the state is so strong, is not a good sign that enrolment in science was still so low during the years covered by the present study.

7.2.2 Performance of Science Students at Various Levels of Education:

In India, evaluation of students is mainly done on the basis of written examination at the end of an academic year. Although this particular form of checking students performance has come against a lot of criticism, no alternative was followed at the time this investigation was done. Therefore, the results obtained by students in the final examinations were taken as the basis for analysing the performance of students at different levels of formal education.

(a) Performance of Students at High School level:

Secondary education is not divided into disciplines. But it has been included for this study because the choice of students for their future depends heavily on their experience at this level. Since it was not possible to clearly depict the performance of stdents in different subjects, he investigator has displayed the overall performance of boys and girls at HSLC level with the hope that it would throw light on the status of students in general.

Table-7.9
Overall Performance of Boys/Girls in HSLC

Year of Exam	Appeared		Total	Passed		Total	Passed Percentage	
	Boys	Girls		Boys	Girls		Boys	Girls
2002	6583	7157	**13740**	3408	3278	**6686**	51.77	45.80
2003	3511	3639	**7150**	1363	990	**3253**	38.82	27.21
2004	5328	6086	**11414**	2327	2143	**4470**	43.67	35.21
2005	5861	6701	**12562**	3411	3408	**6819**	58.20	50.86
2006	4327	4460	**8787**	2251	1915	**4166**	52.02	42.94
2007	5606	5795	**11401**	3398	3098	**6496**	60.61	53.46
2008	5935	6274	**12209**	4070	4101	**8171**	68.58	65.36
2009	6244	6470	**12714**	4050	3952	**8002**	64.86	61.08
2010	7250	7402	**14652**	5132	4808	**9940**	70.79	64.96

Source : MBSE

A critical analysis of Table-7.9 shows that boys were far superior in number in terms of enrolment for examination as well as achievement during the years under study. Throughout the years covered by the study, boys showed a higher percentage when compared to the girls. Besides this, the investigator also found that the total number of students enrolled for HSLC examination also rose steadily each passing year except for two years (i.e. 2003 and 2007) when there were drastic decrease in the number of students enrolled for HSLC examinations. Incidentally, going by records, these were years when there were curricular revisions.

A separate information with regards to the subject of science was possible only from 2008 onwards because it was only since then that the MBSE started to prepare a separate data for each subject. As shown in Table-7.10, there was a wide gap between theory and practical marks. While most of the students scored first or second division marks in the practical examinations, with only a bare minimum failing, it was a very different picture for theory examination. The marks scored in theory paper were the exact opposite of the marks scored in practical work. There were always 53% or more students who scored either distinction or first division in practical work whereas there were only 4% or fewer students who scored distinction mark in theory examination. In short, students showed a far better performance in practical examinations, where marks are obtained internally, rather than theory examinations where marks are obtained externally.

It was also observed in Table-7.10 that there was lesser number of students who appeared for their practical examinations than students who appeared for their theory examinations. The reason is that most repeaters prefer to sit for theory examinations alone because the marks they have scored in the previous examination is still valid for the next examination. Even this practice of depending on the marks scored in a previous examination is cause for concern if one really wants to see positive change in science education.

Table-7.10
Performance of Students in Science at HSLC Examination 2008-2011

Divisional Grade	2008				2009				2010				2011			
	T	%	P	%	T	%	P	%	T	%	P	%	T	%	P	%
Distinction	467	4	6409	53	685	5	7208	57	401	3	7949	54	566	5	8849	81
First	1062	9	4260	35	1240	10	4268	34	1032	7	5417	37	1026	9	1356	12
Second	1476	12	887	7	1542	12	791	6	1700	12	881	6	1624	15	399	4
Third	6188	51	509	4	5807	46	292	2	7817	53	319	2	5155	41	354	3
Fail	2993	24	2	1	3390	27	0	0	3670	25	5	1	2634	24	4	1
TOTAL	**12186**		**12067**		**12664**		**12559**		**14620**		**14571**		**11005**		**10962**	

Source: MBSE

(b) Performance of Students at Higher Secondary School level:

At the same time, their performance also throws light on whether they have made the right choice suited to their temperament and whether they have received the right educational treatment. More importantly, it conveys an invaluable message to the state by indicating where it stands in the field of Science Education and thus the real developmental status of the state at this particular level.

As shown by Table-7.11, the percentage of science students appearing for examinations has steadily grown over the last eight years, but this increase has been slow. Till the last examination, that is, 2010 examination, the percentage of science students was 23.34% of the total number of students who appeared for examinations. This is still a small margin when the total number of students at this level is considered and also at the amount of students who are in the arts stream. A look at the pass percentage of students also shows that the percentage of successful science students has been steadily growing over the years. During the 2002 academic session, the science students made up only 13.37% of the total number of students but by the 2010 session, their percentage rose to 25.66% from the total number of successful candidates. This indicates that science education at this level has not remained static but has improved during the nine years covered by the present study.

Looking at science students alone, based on Table-7.11, their pass percentage is quite good. Especially in the last examination covered by the study, their pass percentage was 69.13%, a high increase from 44.26% that was witnessed in the year 2002 result. However, it was clearly seen that their pass percentage was only slightly higher than that of Arts and lower when compared with Commerce stream. All these show that Science education still has a lot of maturing to do.

(c) Performance of Students at Collegiate Level:

From its inception in the year 2001, Mizoram University has been continuously carrying out examinations for the undergraduate level as well as the post graduate level. Table-7.12 is the performance of science students in the undergraduate examination for science in various subjects like physics, chemistry, botany, zoology, geology, biochemistry and mathematics. A separate column has been prepared to see the difference between honours students and general students

Table- 7.11

Overall Performance of Boys/Girls in H.S.S.L.C

Year of Exam	Stream	Number of Students Appeared		Number of Students Passed		Pass % in each stream
		N	%	N	%	
2002	Arts	5000	86.64	1679	81.98	33.58
	Science	619	10.72	274	13.37	**44.26**
	Commerce	152	2.63	95	5.65	62.5
2003	Arts	5735	85.81	2299	82.84	40.08
	Science	730	10.92	351	12.64	**48.08**
	Commerce	218	3.26	125	4.50	57.33
2004	Arts	5660	83.65	1336	71.75	23.60
	Science	837	12.37	387	20.78	**46.23**
	Commerce	269	3.97	139	7.46	51.67
2005	Arts	5000	78.90	2480	76.92	49.60
	Science	1062	16.75	587	18.20	**55.27**
	Commerce	275	4.33	157	4.86	59.24
2006	Arts	2909	70.79	1722	69.51	59.19
	Science	959	23.33	578	23.33	**55.27**
	Commerce	241	5.84	177	7.14	73.44
2007	Arts	4605	74.46	2661	74.70	57.78
	Science	1279	20.69	712	19.98	**55.66**
	Commerce	296	4.78	189	5.30	63.85
2008	Arts	4585	72.33	2742	73.21	59.80
	Science	1423	22.44	811	21.65	**56.99**
	Commerce	331	5.22	192	5.12	58.00
2009	Arts	5186	71.17	3124	72.29	60.23
	Science	1700	23.33	992	22.95	**58.35**
	Commerce	400	5.48	205	4.74	51.25
2010	Arts	4863	69.77	2944	67.46	60.53
	Science	1620	23.24	1120	25.66	**69.13**
	Commerce	487	6.98	300	6.87	61.60

Source: MBSE

Table- 7.12

Results of IIIrd Year B.Sc Degree Honours and General (Regular and Repeaters) under Mizoram University-2003 to 2010

Year	Honours			General		
	Appeared	Pass	%	Appeared	Pass	%
02-03	93	74	79.57	9	3	33.34
03-04	64	51	79.69	8	5	62.50
04-05	94	75	79.79	6	6	100
05-06	58	55	94.83	2	2	100
06-07	74	55	74.32	3	3	100
07-08	161	122	75.78	6	5	83.83
08-09	279	209	74.91	13	8	61.54
09-10	105	78	74.29	2	2	100

.

Sources: i)Mizoram University ii) Individual Colleges

As seen in Table-7.12, honours students clearly outnumber the general students throughout the years Mizoram University has been in existence, which is a good trend. However, it is interesting to note the sudden rise in the number of students from the academic session 2007 to 2008. From then on, students have not been less than 100. However, the pass percentage been at almost a standstill even with the addition of more students. Except for the year 2006 when the pass percentage rose to 94.83%. As a whole the science students have been showing good results over the years.

General course students, as shown by the table-7.12, are far less in number when compared to the honours students. This is not a surprise because if there is an option most students opt for honours course which has a much better future than a course without an honours. However, other than the year 2002-2003, where they showed a very dismal performance, they have steadily shown a good performance. In fact, they are the ones who have repeatedly given 100% pass percentage, a feat worth mentioning.

7.3 Conclusion:

From the above facts, it can be safely asserted that science education has much growing to do. But it can also be seen that in spite of its late start, it has achieved quite a lot. But it is also obvious that the state can perform much better than it has been doing so far.

A careful study of the enrolment at different levels revealed that although incentives for science have been initiated from the elementary level by the state government, it has not been very successful in garnering the right kind of action. Although there was evidence of growth in enrolment from HSLC to College, it was minimal. Besides this, in view of the growth seen in other subjects, Science Education has not seen remarkable change in terms of enrolment. The percentage of students enrolled in science was continuously less than in Arts. This lesser enrolment was even more pronounced at the college level where the percentage of science students barely came to 11% at the most. Not only this, the percentage of students enrolled in the pass course was still quite high. These facts show without a doubt that the state state still has a lot of growing to do in science educaiton.

A look at the performance of students in science from HSLC to College level shows that students have achieved quite well in science. However, at the HSLC level, around 24% of the students still failed in science. This is alarming because so much rests on their performance at this level. Less than 10% of the students got Distinction and First division marks in their HSLC examination during the period under investigation. In view of the fact that it is only these two upper divisions that usually opt for further educationin science, it is not surprising that the percentage of science students at the higher secondary level was so small. And since higher secondary education is the stage where opportunity is open for professional education as well as technical education, students drift away from mainstream Science Education. From those who are left, the ones who have not performed well change their options and move to Arts, some discontinue their studies and finally only a small number of students can continue their education in science. Even among the small number who have been able to continue science education, it was disheartening to note that while students enroled in pass course were able to achieve 100% success in some years, but those enrolled in the honours course were only able to achieve around 75% success.

The final question as to why this low growth rate in science education matters so much can only be answered in one way. It affects the overall growth and development of the state. Unless and until the state is self sufficient in the supply of man-power needs in science, it cannot call itself a thriving state. According to the All India Area and Population State Wise Census 2001[15], the total number of population of Mizoram was 8,88,573. But Mizoram has only been able to produce a handful of science graduates. As shown by the annual reports of Mizoram University, the maximum number of science graduates produced in one year was 217 in the academic year 2008-2009. This means that Mizoram was able

[15] **Statistical Handbook Mizoram 2010**; Directorate of Economics and Statistics: Mizoram Aizawl

to provide only 24 science graduates for 1 lakh population even in its best year. This number does not even adequately provide the man power needs of the state at the school level, let alone the rest of the developmental requirements of the state.

Besides the number of science graduates, another threat that looms in the horizon is a work force totally comprised of employees from outside. Already there seems to be quite a good number coming from outside the state. In spite of relaxation existing for tribals, it is tragic to find non Mizos acquiring the best many of the best jobs. This means that in order to find employment many Mizos will have to go outside the state. But in country like India where performance in written examinations matter so much, will they be able to find the right job? Will they be able to compete in the outside world? These are questions that need immediate answers.

Quite a lot has been said about the importance of Science Education and how it affects national growth. Therefore it is a wonder that Mizoram, in spite of the incentives made for science education has shown such minimal development in science education. The fact that out of 95 higher secondary schools, only 27 could offer science and that out of 23 higher education institutions affiliated to Mizoram University, only 6 colleges exist for science education are causes for worry. The practical activities at highschool level as shown in Chapter-V was dismal and those at the higher levels did not do too well either. All these facts combined have given the state a science education system that leaves much to be desired. Considering the practical importance of science at the societal and national level, it is high time for the state to wake up and try to achieve qualitative and quantitative growth in Science Education.

CHAPTER-VIII
FINDINGS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

8.0 Introduction:

The present chapter has been prepared so as to show the reader a general summary of the findings of this research along with some recommendation and, as already indicated by the title, some suggestions for further research.

8.1 Findings:

Details of the findings have already been presented in the other chapters. However, this chapter hopes to give the reader an easy view of some major points with regards to how the objectives were met. The findings have been broken down as follows:

8.1.1 Findings Relating to Development of Science Education in Mizoram:

1. High School Level:

In the year 1935, a private high school offering science as a subject was opened for a short while in Kulikawn area within the town of Aizawl, the capital of Mizoram.

-It was only in 1945 that the first proper High School was established in Aizawl and this was soon taken over by the Assam State Govt.

-In the year 1947, the year when India gained independence from the British, there were only two high schools in Mizoram.

-By the time Mizoram became a Union Territory of India in 1972, there were 70 high schools, all of them offering science as a subject and fourteen years later, when it became a full fledged state, the number grew to 154.

-During the time this investigation was made, there were 508 high schools in Mizoram, 195 of them managed by the Government, 8 of them deficit and 305 schools managed privately.

2. Higher Secondary Schools:

-These institutions made their appearance in the state in the year 1996.

- Initially, classes were conducted in 7 colleges.

-During the time this study was conducted, there was a total of 27 institutions offering science as a subject.

-11 schools were provincialised, 5 of them were partly managed by the Government and private bodies (deficit) and 11 of them were purely private.

3. College level:

-Science stream was opened in 1973 in Aizawl, and the Mizos could get science education in the fields of Physics, Chemistry, Botany, Zoology and later on in Geology. Since then, more colleges offering P.U.Science education (before the opening of higher secondary schools) and B.Sc. degree were opened.

-During the time the study was done, there were a total of six colleges offering science as a subject, all of them undertaken by the Government.

8.1.2 Findings Relating to Science Promotion Wing:

The study revealed that:

a) The science promotion wing of the state had been functioning as just another wing under the SCERT and that no special treatment has been given to it.
b) There were a number of vacant posts not filled up.
c) The Wing had not introduced any new scheme to provide incentive for science education in the past ten years. However, it still continued to involve itself with the following activities:
    i) Training of Science and Mathematics school teachers on an annual basis.
    ii) Supply of science kits and science equipments to middle, high and higher secondary schools.
    iii) Organisation of science exhibitions.
    iv) Participation in Eastern India Science Fair held in Kolkata every year.
    v) Holding of science seminars.
    vi) Cash award for meritorious students.

d) Supervision of schools was also done but this again was not as regular as in the early years when the Science Promotion Wing functioned as an independent body.

e) The funds allocated for the wing has steadily increased from Rs.8.10 lakhs under non-plan and Rs.10.73 lakhs under planned heads during the 1987 – 1988 session to Rs.58.80 lakhs from non-plan and Rs.28.60 lakhs under plan heads during the 2007 to 2008 session.

8.1.3. Findings Relating to Profile of Science Teachers:

1. Profile of Science Teachers at Secondary level:

i) Academic Profile: Only 6.11% were having M.Sc. degree; 1.69% had M.A and M.Com degree; 79.79% had B.Sc. degree (the required degree); 12.05% had BA/B.Com/B.E./B.Tech degree and 0.33% had only P.U. Sc. qualification.

ii) Professional Profile: Only 44% of the teachers had a professional degree.

iii) Gender Profile: Against 78% male teachers, there were only 22% female teachers.

iv) Age Profile: The age of teachers as shown by the records revealed that 13% of the teachers were more than 50 years of age, 35% of them were between 40 to 49 years, 42% were between 30 to39 years and only 10% of them were below 29 years of age.

v) Teaching Experience Profile: In terms of teaching experience, 17% had less than five years teaching experience, 23% of the teachers had 5 to 9 years experience, 22% of the teachers had 10 to 14 years,23% of them had 15 to 19years experience, and 15% had 20 and more years of teaching experience.

2. Profile of Science Teachers at Higher Secondary Level:

i)Academic Profile: It was found that 98% of the science teachers had M.Sc. degree; 1% had MCA and another 1% of them had BE degree.

ii) Professional Profile: It was also shown that 45% of them had a professional degree from a recognised University.

iii) Gender Profile: Only 35% of the teachers were female while 65% of them were male teachers.

iv)Age Profile: The age of teachers as shown by the records revealed that 3% of the teachers were more than 50 years of age, 17% of them were between 40 to 49 years, 66% were between 30 to39 years and only 14% of them were below 29 years of age.

v) Teaching Experience Profile: In terms of teaching experience, 46% had less than five years teaching experience, 24% of the teachers had 5 to 9 years experience, 29% of the teachers had 10 to 14 years of teaching, just 1% of them had 15 to 19years experience and none of the teachers had 20 or more years of teaching experience.

b) Profile of Science Teachers at the Collegiate level:

i) Academic Profile: At the college level, it was discovered that 100% of the teachers had M.Sc. qualification. It was also reported that 28% of them had a Ph.D. degree.

ii) Gender Profile: Gender wise distribution was still not quite satisfactory with 62% of the teachers being male and only 38% of them being female.

iii) Age Profile: The age of teachers as shown by the records revealed that 9% of the teachers were more than 50 years of age, 36% of them were between 40 to 49 years, 46% were between 30 to 39 years and only 10 % of them were below 29 years of age.

iv) Teaching Experience Profile: In terms of teaching experience, 17% had less than five years teaching experience, 14% of the teachers had 5 to 9 years experience, 37% of the teachers had 10 to 14 years of teaching, just 16% of them had 15 to 19 years experience and another 16% of the teachers had 20 or more years of teaching experience.

8.1.4 Findings Relating to Status of Science Laboratories in High and Higher Secondary Schools:

1. Status of Science Laboratories-High Schools

i) Availability of Equipment and Apparatus Relating to Physics:

-32 % of them had more than 75% of the specified apparatus and equipment.

-32% had more than 50% of the required apparatus and equipment.

-28% of the schools had less than half of the required apparatus and equipment.

-8% of the schools still had less than 25% of the required apparatus and equipment.

ii) Availability of Equipment and Apparatus Relating to Chemistry:

-40% of the sample high schools were found to have more than 75% of the required apparatus and equipment in chemistry.

-48% of the schools who had 50% to 75% of the required apparatus and equipment.

-8% of the sample schools had only 25% to 50% of the prescribed apparatus

-4% of the sample schools had none of the prescribed apparatus.

iii)Availability of Chemicals:

- 32% of the sample high schools had more than 75% of the prescribed chemicals.
- 16% of the sample schools had 50% to 75% of the prescribed chemicals.
- 32% of the selected schools had only 25% to 50% of the prescribed chemicals.
- 16% of the selected schools had less than 25% of the prescribed chemicals
- 4% of the sample high schools still had none of the prescribed chemicals to carry out experiments.

iv) Availability of Equipments and Apparatus Relating to Biology:

- 28% of the sample high schools had above 75% of the required apparatus and equipment.
- 36% of the high schools selected as sample had 50% to 75% of the required materials.
- 24% each, of the schools had less than 50% and slightly more than 25% of the required apparatus and equipment.
- 4% of the schools still had less than 25% of the specified apparatus and equipment.
- 8% of the schools still operated their biology classes with no practical work.

v) Availability of Charts:

- 25% of the schools selected as sample high schools had 75% of the required charts.
- 24% of the sample schools had 50% to 75% of the required charts only.

- 16% of the sample high schools had 25% to 50% of the required charts.
- 4% of them had less than 25% of the required charts for biology practical.
- 31% of the sample schools did not have any chart.

2. Status of Science Laboratories in Higher Secondary Schools:

i) Status of Physics Laboratory:

-None of the sample higher secondary schools had more than 75% of the specified apparatus and equipment.

-60% of the sample schools had only 50% to 75% of the required apparatus and equipment.

-27% of the sample schools had 25% to 50% of the required materials.

-13% of the sample schools had below 25% of the required materials.

ii) Status of Chemistry Laboratory:

a) Apparatus and equipment:

-60% of the sample higher secondary schools had more than 75% of the required apparatus and equipment

-33% of the sample schools had 50% to 75% of the required apparatus and equipment.

-7% of the sample schools still managed with less than 50% of the required apparatus and equipment.

b) Chemicals:

-40% of the sample higher secondary schools had more than 75% of the required chemicals.

-40% of the sample higher secondary schools had only 50% to75% of the required chemicals.

-20% of the sample higher secondary schools had less than 50% of the required chemicals.

ii) Status of Biology Laboratory:

a) Apparatus and Equipment:

-7% of the sample higher secondary schools had above 75% of the required apparatus and equipment.

- 60% of the sample higher secondary schools still had only 50% to 75% of the prescribed apparatus and equipment

- 26% of the sample higher secondary schools managed with 25% to 50% of the required materials.

- 7% of the sample higher secondary schools still had less than 25 % of the required apparatus and equipment.

b) Chemicals:

-33% of the sample higher secondary schools had more than 75% of the required chemicals.

-53% of the sample higher secondary schools had only 50% to 75% of the required chemicals.

-7% of the sample higher secondary schools had just 25% to 50% of the necessary chemicals

-7% of the sample higher secondary schools did not have one item in the list.

c) Permanent Slides:

- 67 % of the sample higher secondary schools had more than 75% of the total permanent slides as demanded by the MBSE.

- 20% of the sample higher secondary schools had just 50% to 75% of the required permanent slides.

- 13% of the sample higher secondary schools had no permanent slides at all.

d) Specimens:

- 13% of the sample higher secondary schools had more than 75% of the specified specimens for biology practical class.

- 20% of the sample higher secondary schools had 50% to 75% of the necessary specimens.

- 34% of these sample higher secondary schools still managed with 25% to 50% of the specified specimens.

- 13% of the sample schools had less than 25% of the prescribed specimens.

- 20% of the sample higher secondary schools had no specimens at all.

e) Charts:

- 34% of the sample higher secondary schools had more than 75% of the required charts

- 27% of the sample higher secondary schools had only 50% to 75% of the specified charts.

- 13% of the sample higher secondary schools had just 25% to 50% of the total number of charts prescribed by the MBSE.

- 13%of the sample higher secondary schools had below 25% of the charts considered necessary.

-13% of the sample higher secondary schools had no chart at all.

f) Furniture:

-40% of the sample schools had more than 75% of the required furniture in their biology laboratories.

-33%of the sample higher secondary schools had 50% to 75% of the required furniture.

-27% of the sample higher secondary schools had less than 50% of the specified furniture.

-7% of the sample higher secondary schools had even less than 25% of the required furniture items and other relevant articles.

3. Collegiate level

No such information as was possible for high and higher secondary schools could be collected. This was due to the fact that the affiliating body, Mizoram University, has not laid down any specifications with regards to the amount and quality of laboratory equipment.

8.1.5 Status of Practical Work at High School, Higher Secondary School and Collegiate Level:

1. Status of Practical Work at High school level:

-20% of the sample high schools did not have a laboratory.

-56% of the sample high schools did not have a practical class on a weekly basis.

-32% of the sample high schools could have one practical class in a week.

-4% of the sample high schools had two practical classes.

-4% of them could have three practical classes and

-4% of the sample high schools could conduct four practical classes in a week.

2. Status of Practical Work at Higher secondary level:

-100% of the sample higher secondary schools had a separate laboratory for physics, chemistry and biology.

-20% of the sample higher secondary schools had less than four practical classes in a week.

-46% of the sample higher secondary schools had four to six practical classes in a week.

-27% of them could have seven to nine practical classes in a week.

-7% of the sample higher secondary schools could have ten to twelve practical classes in a week.

3. Status of Practical Work at Collegiate level:

-100% of the sample colleges had a separate laboratory for each course in science subjects.

- 83% of the colleges could hold more than four practical classes in a week.

- 17% of them could have more than ten practical classes in a week.

4. Status of Laboratory Staff in Colleges:

- It was found that 50% of the colleges teaching science still functioned with no laboratory assistant in any of the subjects at the time the investigation was done.

- Only 17% of the colleges had a laboratory assistant for 4 subjects.

- Only 50% of the colleges had one laboratory attendant for each subject.

- 17% of the colleges still had to function with just one laboratory attendant.

8.1.6 Analysis of Time Table:

1. High School Level:

a) Theory classes:

-4% of the sample high schools could give 12 theory classes in a week for science subjects.

-12% of the sample high schools could give 9 science theory classes in a week for science subjects.

-8% of the sample high schools could give 8 science theory classes in a week for science subjects.

-56% of the sample high schools could give 7 science theory classes in a week for science subjects.

-20% of the sample high schools could give a minimum of 6 theory classes in a week for science subjects.

b) Practical Classes:

- 4% of the sample high schools could have 2 practical classes in a week.
- 96% of the sample high schools did not make allotment for practical classes in their time table.

2. Higher Secondary Level:

1. Class XI

a) Theory Classes:

i) Physics:

- 27% of the sample higher secondary schools could have 8 or more theory classes in a week.
- 40% of the sample higher secondary schools could have 6 theory classes in a week.

-33% of the sample higher secondary schools could have 5 theory classes in a week.

- 20% of the sample higher secondary schools could have only 4 classes in a week.

ii) Chemistry:

- 13% of the sample higher secondary schools could have 8 or more theory classes in a week.
- 13% of the sample higher secondary schools could have only 4 theory classes in a week.

-20% of them could have 6 classes in a week.

- 40% of the sample schools had 5 theory classes in a week.

-13% of the sample higher secondary schools showed only 4 classes in a week.

iii) Biology:

-20% of the sample higher secondary schools could have 8 or more theory classes in a week.

-13% of the sample schools could have 7 theory classes in a week.

-20% could have 6 classes in a week.

-33% could have 5 theory classes in a week.

-13% of the sample higher secondary schools could not have more than 4 theory classes in a week.

b) Practical classes:

-47% of the sample higher secondary schools showed that they could have 2 practical classes in a week.

-20% of the sample higher secondary schools set aside 4 classes for practical classes in a week without specifying the subject whose practical work would be taken up.

-33% of the sample higher secondary schools did not show any place for practical work as shown by the time table.

2. Class XII

A. Physics:

a) Theory classes:

- 20% of the sample higher secondary schools had 3 theory classes in a week.
- 13% each, of the sample higher secondary schools could have 6 and 4 theory classes in a week.
- 27% each, of the sample higher secondary schools could have 7 and 5 theory classes in a week.

b) Practical classes:

-53% of them could have at least 2 practical classes in a week.

-47% did not show any allotment for physics in their time table.

B. Chemistry:

a) Theory classes:

- 20% each, had 8 or more, 7 and 6 theory classes respectively, in a week.

- 27% of the sample higher secondary schools could have 5 theory classes in a week.
- 13% of the sample higher secondary schools could have only 4 theory classes in a week.

b) Practical classes:

- 53% of the sample higher secondary schools could give 2 practical classes in a week.
- 47% of the sample higher secondary schools could not give any practical work as indicated by their time table.

C. Biology:

a) Theory classes:

- 13% each, of the sample higher secondary schools could give 8 or more and 7 theory classes in a week.
- 23% each, of the sample higher secondary schools could have 5 and 6 practical classes in a week.

-20% of the sample higher secondary schools still showed that they could not give more than 4 theory classes in a week.

b) Practical classes:

- 6% of the sample higher secondary schools could give 4 practical classes in a week.

-47%of the sample higher secondary schools could have 2 practical classes in a week.

-47%of the sample higher secondary schools could had no practical classes in a week.

3. Collegiate level:

A. Macro analysis

-For the honours courses, from the first to the third year, theory classes took an average of 72% of the total classes in a week.

-For general course, 73% of the entire classes in a week were taken up by theory classes.

B. Micro analysis

1st year B.Sc. Honours

- Pachhunga University College which devoted 60% to theory classes and 40% to practical classes.
- The rest of the colleges that offered science subject gave less than 30% of the classes for practical works.
- The least time devoted to practical work was by Champhai Gov't. College which only gave 17% of the classes to practical works as shown by their time table.

1st year B.Sc. General

- 100% of the colleges offering science courses devoted more than 70% of their time to theory classes as shown by their time table.
- None of the colleges gave more than 30% to practical work.

2nd year B.Sc.Honours

- Time devoted to theory classes ranged from 71% to 83% of the total classes in a week.
- The classes devoted to practical works ranged between 17% to 29% of the total number of classes in a week as shown by their time tables.

2nd year B.Sc. General

- 50% of the sample colleges gave more than 80% to theory classes and devoted only the rest 20% for practical classes.

3rd year B.Sc.Honours

- 17% of the colleges could devote 36% of the total number of classes in a week for practical classes.

3rd year B.Sc. General

-30% of the colleges gave 30% of the total number of classes in a week to practical class.

8.1.7 Science Education Policy:

- At the time of the investigation, no written policy like the one existing for the nation (National Policy of Education) existed in the state.

- There were documentary proofs to show that the state had been investing some amount for science education from secondary to college level.
- At the secondary and higher secondary levels, incentive for science education was mainly given through the Science Promotion Wing.
- At the college level, special scholarships were awarded through the department of Science and Technology. But these funds were still obtained from the planned funds.

8.1.8 Student Teacher Ratio:

1. High school level:

i) Class VIII

-32% of the sample schools had student teacher ratio of 1:10 to 1:25.

-20% of the sample schools had student teacher ratio of 1:26 to 1:40.

-16% of the sample schools had student teacher ratio of 1:41 to 1:55.

-16% of the sample schools had student teacher ratio of 1:56 to 1:70.

-16% of the sample schools had student teacher ratio of 1:71 and above.

- The overall student teacher ratio at this level was 1:42.

ii) Class IX

-28% of the sample schools had student teacher ratio of 1:10 to 1:25

-40% of the sample schools had student teacher ratio of 1:26 to 1:40

-12% of the sample schools had student teacher ratio of 1:41 to 1:55

-4% of the sample schools had student teacher ratio of1:56 to 1:70

-16% of the sample schools had student teacher ratio of 1:10 to 1:25

- The overall student teacher ratio was 1: 36.

iii) Class X

- This stage had the best profile because 76% of the sample schools fell within the desirable range.
- The overall student teacher ratio at this level was 1:25.

2. Higher secondary level: The student teacher ratio of Class XII level, strongly indicated that the student teacher ratio in the sample higher secondary schools falls below the national average of 1:42(UNICEF 2004). But this was still much higher than the ideal situation of 1:20 as calculated by Western educationists. However, it may also be pertinent to mention here that especially in the case of Biology, 67% of the sample secondary schools were within the desired range of 1:25. Only 13% of the sample higher secondary schools were outside the desirable ratio. However, in the subjects of physics and chemistry, the student teacher ratio still remained at 1:33, when this study was undertaken. The overall student teacher ratio showed that there was a ratio of 1:20, 1:20 and 1:16 in the subjects of Physics, Chemistry and Biology respectively.

Collegiate level:

-The first, second and third year students showed a ratio of less than 1:10, with only the first year batch surpassing the norm of 1:10.

-The overall student teacher ratio at the college level was barely 1:6.

8.1.9 Findings Relating to Development of Human Resources in Science:

1. Enrolment:

a) Enrolment at the HSLC Level:

- Unlike other states where enrolment almost always showed the number of boys much higher than girls, during the years covered by the study, girls consistently made up 50% or more than that when compared to boys.

- Comparison of figures of enrolment of 2000 and 2010, showed a growth of 21.17%.

- Around 1.3% to 1.7% of the total population of Mizoram at a particular time (during 2000 to 2010) was enrolled in the HSLC

- The number of students per lakh enrolled in HSLC during 2000 to 2010 varied from 1333 to 1777.

b) Enrolment at HSSLC Level:

i) Enrolmentin Class XI

-70% to 75% of students in Class XI during the period 2004-2010 were enrolled in Arts.

-6% to 12% of students in Class XI during the period 2004-2010 were enrolled in Commerce.

-17% to 24% students in Class XI during the period 2004-2010 were enrolled in Science.

ii) Enrolment in Class XII

- 70% to 79% of students in Class XI during the period 2004-2010 were enrolled in Arts.

- 5% to 8% of students in Class XI during the period 2004-2010 were enrolled in Commerce.

-16% to 21% students in Class XI during the period 2004-2010 were enrolled in Science.

c) Enrolment at College Level:

Overall Enrolment in Science:

- 3.6% to 11.46% students at college level during the period 2004-2010 were enrolled in Science.

- More than 85% of the students at college level enrolled in scienceduring the period 2004-2010 were in honours courses.

- The percentage of science students enrolled in honours decreased from 93.4% in 2004 to 89.6% in 2010.

- The percentage of science students enrolled in general course increased from 6.6% in 2004 to 10.4% in 2010.

2. Examination Results

a) At HSLC Level:

-The number of students taking examination at HSLC level increased from 13740 in 2002 to 14652 in 2010

-The number of students passing examination at HSLC level increased from 6686 in 2002 to 9940 in 2010.

-The percentage of students passing examination at HSLC level increased from 49% in 2002 to 68% in 2010.

-There was a wide gap between theory and practical marks in science. While most of the students scored first or second division marks in the practical examinations, with only a bare minimum failing, it was a very different picture for theory examination. The marks scored in theory paper were the exact opposite of the marks scored in practical work.

- There were always 53% or more students who scored either distinction or first division in practical work whereas there were only 4% or fewer students who scored distinction mark in theory examination.

-Boys in comparison to girls showed a consistently higher pass percentage throughout the period covered by the study.

-The percentage of girls taking HSLC examination continuously remained higher than that of boys. However, this difference was not very sharp, with the percentage of boys averaging 48% and that of girls averaging 52%.

b) At HSSLC Level:

-The number of science students taking HSSLC examination increased from 619 in 2002 to 1620 in 2010.

-The number of science students passing HSSLC examination increased from 274 in 2002 to 1120 in 2010.

-The percentage of science students passing examination at HSLC level increased from 44.26% in 2002 to 61.6% in 2010.

-During 2002 around 13.37% of students passing HSSLC examination were from science stream, and this percentage increased to 25.66% in 2010.

c) At College Level:

-The number of science students that took B.Sc (Honours) examination was 93 in 2002-03, 161 in 2007-08, 279 in 2008-09 and 105 in 2009-2010

-The number of science students that passed B.Sc (Honours) examination was 74 in 2002-03, 122 in 2007-08, 209 in 2008-09 and 78 in 2009-2010

-The percentage of science students passing B.Sc (Honours) examination decreased from 79.57% in 2002 to 74.29% in 2010.

-General course students, as indicated by the investigation, were far less in number when compared to the honours students.

8.2 Recommendations:

1. Development of Science Education in Mizoram:

(a) High Schools:

Although the number of high schools had increased, it was found that maximum number of them were privately managed. Purely private schools found it difficult to retain teachers because they could not offer good remuneration. Especially in the case of science where stability plays such an important factor, the investigator would like propose for better incentives to be given to the science teachers working in private schools.

(b) Higher Secondary Schools:

Institutions offering science were too few in number to take care of the needs of the growing population. As such, only those students who had done well in HSLC science subjects were able to get admission. For this reason, the researcher recommends that schools be opened in each district so that science education at this level is available to maximum number of students. Besides this, the scholar would also like to recommend that at least one model institution be opened within the state.

(c) Colleges:

The developmental trend of colleges showed that although the number of colleges offering science education had increased, the subjects offered at the time the investigation was done were only classical science subjects. In this regard, the investigator would like to recommend that subjects in applied sciences which are now in much demand, be introduced. This would not only stop more students to pursue higher education outside the state but would also attract more students from outside the state.

2. The Science Promotion Wing:

(a) The Science Promotion wing has been functioning as just another wing under the SCERT. In view of the urgent call for a more focused drive for the development of science education in the state, the investigator would like to recommend that this wing be given a chance to mature as an independent department under a qualified director who has vision and will to strive for a more sustainable development in science education. If a totally separate department is not possible, then it might be prudent to give this wing more autonomy than it enjoys at the present.

(b) As found in the financial report, the wing did not seem to have enough funds to take care of the laboratory needs of all the schools. This is a major hindrance to the development of science education which is almost entirely based on practical work. Therefore, the scholar would like to suggest an increase in the financial grants given to the wing. This raise in the financial aid should not only be for the schools but also for the improvement of the wing itself since this would ultimately benefit the schools in the long run.

(c) The Wing had mostly been functioning as a training centre for middle and secondary science and mathematics teachers. But the study showed that it was able to cover only a small percentage of teachers each year. Therefore, the researcher would like to recommend that training of teachers be done more rigorously so that teachers from rural and urban areas are given equal opportunity to grow and develop while getting oriented to new syllabus.

3. Science teachers:

(a) Professional Training:

Based on the study conducted on science teachers from secondary to college level, it was found that although secondary school teachers showed a better profile in terms of training, higher secondary school teachers showed a poor profile. In this regard the investigator would like to recommend a better defined form of recruitment rules be provided. Science teachers are no longer allowed to go for training on deputation as was practiced earlier. This may be indirectly responsible for lesser number of teachers getting a professional degree. Since training is such an important element in the making of good teachers other than the positive effect it has on their remuneration, teachers should be given an opportunity to improve their skills under proper training.

The fact that trained teachers, both at the HSLC and HSSLC levels made a smaller percentage when compared with untrained teachers clearly showed that better incentives and opportunities need to be given for the training of teachers.

Since human resources are of vital importance in this field, it is only through the improvement of the human resources that any improvement in science education would be meaningful. In this regard, the investigator would like to recommend that more stress be given to in-service training. Since college teachers also need professional training, the state government might even make arrangements with the only Central University it has, i.e. Mizoram University to provide short term training to college teachers other than the usual refresher courses.

(b) Gender:

The investigator was surprised to find a huge disparity in terms of gender still in existence among the teachers at different levels of the education system under study. Since the enrolment also revealed there to be more male students than female students, the investigator would like to recommend that science education be made more accessible to female students. In this way, male and female teachers would soon be equal in number and there would soon be a closing of this ugly gap.

(c) Teaching Experience:

As found in the investigation, most of the teachers from secondary school were found to be having at least ten years experience in teaching. But at the colleges, it was found that there were still a number of teachers who were less than five years in their profession.

(d) Age:

The study revealed that maximum number of the teachers from secondary to college level fall between the age group of 30 to 40. In consideration of the fact that the retirement age of teachers is 60, these teachers will be in their job for at least another 20 years. The life of students for the next 20 years will depend on them. In view of the above, the investigator would like to recommend that these teachers be given regular in-service training so as to update themselves with changing topics in science education.

(e) Qualification:

The investigator was disappointed to find a number of unqualified teachers teaching science in secondary schools. In this regard, she would like to recommend for stringent efforts to be taken in the recruitment of teachers. This would not only affect the students' morale but also raise the standards of science education in the state.

4. Laboratory:

In this day and age where everybody accepts science education as a laboratory based subject, it was a real disappointment to find so many secondary schools without laboratory. The sample higher secondary schools also did not fare well in terms of having a separate laboratory for each subject in science. Therefore, the investigator would like to recommend that the MBSE takes a more serious stand on this since this affects the future of the students and the state.

5. Practical Work:

The scholar was surprised to find science teaching at the secondary level quite theory based rather than practical work. Most of the secondary schools did not have practical classes in their weekly routine. Upon enquiry, it was found that neither MBSE nor SCERT had laid down a model time table to be followed by schools. The scholar strongly recommends that a model time table be set so that schools will know which subjects to give priority to.

Practical classes were taken up by the secondary schools near the start of their external examination and this had left no time for students to understand the beauty of science. This could be one of the reasons why the enrolment was much lower for science than for other subjects at the higher secondary and college levels. If the state wants to see an improvement in science education, the investigator would like to recommend that secondary education be given a major boost in science education because this is the stage where students start to make choices for their further studies.

It was a difficult task trying to assess the collegiate level practical work . This was mainly because the affiliating body, Mizoram University had not laid down a specific norm to be followed by the colleges. In this regard the scholar would like to recommend that the University modifies its rules of affiliation as soon as possible so as to make a clear plan for colleges to follow.

6. Analysis of time tables:

The evidence shown by time tables and that of the responses received through the interview schedule did not match, a fact noted by the scholar. Going by the distribution of theory and practical classes as given in their time tables, it was obvious that ample time was not given to practical classes from HSLC till college level. Therefore, the examiner would like to recommend the addition of funds for practical classes at all levels. Furthermore, she would also like to recommend that science teachers at various levels be reoriented in the use of inexpensive and common kitchen appliances for the performance of practical works.

7. Science Education Policy:

Even after much investigation, the scholar could not locate a specific policy for science education being practiced in the state. Since a major overhaul would only have meaning if done in a systematic way that would benefit both urban and rural areas, the scholar would like to recommend that the state government take immediate steps to form a committee that would look into the problem of science education in the state and frame a suitable policy for science education to be followed at different levels within the state.

8. Student Teacher Ratio:

While the student teacher ratio was quite commendable at the HSLC and HSSLC levels, the fact that there were almost the same number of students and teachers at the college level was serious enough to give cause for worry. If this continues to be the student teacher ratio, college education for science is certainly going to be too expensive for the young state to carry on its shoulders even with most of the financial needs being borne by the Central Government. Therefore, the scholar strongly recommends that a separate study be made for science education at this level and if necessary to close science education in some colleges so as to ensure better facilities for the remaining colleges and also ensuring that each district has a quota for admission into the few colleges for science education.

9. Enrolment:

At HSLC level, the investigator could not make much recommendations for science education because science education at this level could not be studied separately due to the application of a common set of subjects for all students.

At the HSSLC level, it was found that till the last academic session covered by the study, enrolment in science was continuously less than 25% of the total enrolment. In this case, the investigator would like to recommend that the cut off mark for science education be made slightly lower so as to attract more students(Although the MBSE has no written criteria for admission into science, most schools adhere to an unspoken rule by which only those who have performed relatively well in their HSLC examination are admitted). Furthermore, the scholar would also like to recommend for more seats to be made available for science education both in urban and rural areas.

At the College level, students mostly concentrated themselves in the two city colleges leaving only a few for colleges outside the capital. The investigator found this a huge waste of funds because education becomes too expensive, especially for a young state like Mizoram who has hardly any income to speak of. Therefore, she would like to recommend that another study entirely focusing on this issue be made. And if supported by findings, let there be just two colleges in the city with a separate quota for each district. Let these two colleges be given better and more equipment so as to enable them to admit more students and study a wider range of science subjects.

10. Examination results:

Based on the examination results of the HSLC examination, it was found the examination results in theory and practical were exactly opposite. Whereas more number of students scored distinction mark in practical work, less than 5% of the students scored distinction mark in theory examination. In this regard, the investigator would like to recommend that a more reliable system of evaluation be taken with practical examination. Moreover, she also recommends that practical work should not remain totally internalised but be witnessed by a qualified external examiner.

Based on the findings of examination results at the HSSLC level, the percentage taken up by science students in the overall pass percentage was only 25.66% at the maximum. This was mainly because science students were only a small margin out of the total number of students who appeared for their HSSLC examination. Therefore the investigator recommends that opportunity for science education be widened both in terms of infrastructure as well as relaxation in admission criteria (while not sacrificing quality).

The pass percentage of science students both for honours as well as general course was found to be good with their maximum performances being 94.83% and 100% respectively. However, since the total number of successful candidates were far less in number than the actual needs of the state, the investigator would like to recommend that more students be admitted in science education at this level. At the same time, the investigator would like to recommend that honours courses be given more encouragement instead of general courses since these specific courses give better chances for higher studies and thus mean higher development in science education, which is one of the major needs of the state.

8.3 Suggestions for Further Research:

Based on the findings, the investigator would like to that further research be done on the following subjects:

1. A study on Attitude and Perceptions of Teachers, Students and the Mizo Community toward Science Education.
2. Science education in Mizoram: Issues and Concerns.
3. A study on scientific aptitude of students at different levels of education.
4. A study on achievement in science in relation to cognitive, affective and socio-cultural characteristics of students.
5. A study on the gap between the man-power requirement in science and technology and development of human resources in Mizoram.

6. A study on the effect of medium of instruction at MSLC level on the academic achievement in science at HSLC, HSSLC and Collegiate Education.
7. A comparative study on the teaching learning process and evaluation in science at different levels of education.
8. A study on the gender and regional imbalances in the field of science education in Mizoram.
9. A comparative study of science education in North-East India.
10. A critical analysis of State Government spending on science, technical and general education in Mizoram.
11. An analysis of curriculum of science education at different levels of education.
12. A critical study of attitudes of science students in rural and urban areas within the state of Mizoram.

8.4 Conclusion:

From the present study on science education which spanned nine years, the investigator concluded that in spite of its late entrance, especially at higher education level, science education has slowly but steadily shown an improvement within the state. However, it was apparent that that state had much growing to do in science education. The fact that most of the institutions that offered science were concentrated in the capital city made a poor first impression.

Till the last academic session covered by the study, the state had not had a specific policy for science education, no proper monitoring system to check the practical work on science and a very low enrolment in science education from HSSLC onwards. The student teacher ratio at high school level was not at all safe. On the other hand, the almost equal number of teachers and students at the college level indicates just how expensive science education was for the state during the time the study was conducted. The uneven distribution of theory and practical work from high school till college level was highly undesirable. The poor condition of the Science Promotion Wing also showed the absence of active support in this field. All these strongly indicated the need for a major boost to be given to science education taking into consideration the major areas that needed to be improved starting from human resources and including better infrastructure.

The study did reveal that there was a good distribution of teachers in terms of age at all the different levels of education under study. This balanced blend of mature and young minds was a valuable situation that the state should definitely utilize. However, the uneven distribution of male and female teachers from high school to college level was not a beautiful sight to see in a state where the society appeared so positive to female education.

In conclusion, it may be asserted yet again that science education is an endeavour each state needs to improve on if it wants to be a growing and developing state. The young state of Mizoram has no better ammunition than science education to be a state worth investing in and to ensure maximum empowerment for its citizens. The sooner it makes friends with science education, the quicker would its steps be as a participator in the march for an enlightened India.

Bibliography

Ahuja, R . (2001) . Research Methods. Rawat Publications. New Delhi.

Alexander, Benny, (1990). A study of the relationship of critical thinking, science aptitude and socio-economic status to the science achievement of second year PUC. students. M.Phil., Edu. Bangalore Univ.

Anwar, G. (1991). A study of the effect of short-term content enrichment programme to overcome the deficiencies of trainees in science subjects in TCH course. Ph.D. Edu. Univ. of Mysore.

Bandura, A. (1997). Self-efficacy : the exercise of control. New York: W.H. Freeman.
Bhattacharya. P (1979) . A Critical Study of Science Education in Assam and Meghalaya Schools, Ph.D. Edn. Gauhati University.

Burman (2004) as quoted in Pienju, K. 'A study of the Status and Development of Science Education at High and Higher Secondary School Level in Nagaland since its Statehood. Ph. D thesis (unpublished). Nagaland University.

Chuaungo, L (2001) An Analytical Study of Pre- School Education in Mizoram.Ph.D. NEHU.

Cone, N(2009). A Bridge to Developing Efficacious Teachers of All Students: Community Based Service Learning Supplemented with Explicit Discussions and Activities about Diversity. Published online-(2009). Springer Science+Business Media, B.V. 2009

Cheriyan, Molley. (1988). Facilitations amid hindrances to the modernisation of chemistry teaching in the schools of Kerala. Ph.D., Edu. Univ. of Kerala.

Darchhingpui,(1989). A study of science achievement, science attitude and problem-solving ability among secondary school students in Aizawl. Ph.D., Edu. North Eastern Hill Univ

Dubey, K.K. (1992). A study of the scientific temper and its measurement. Ph.D., Edu. Rani Durgavati Vishwavidyalaya.

Deshmukh, A.L. (1991). Science education as a means of social change with special respect to health and hygienic habits. Ph.D., Edu. Univ. of Poona.

Durani, P.K. and Sarma, A.L.N. (1982). Know the life between tide marks. Independent study. Bhubaneswar: Regional College of Education.

Ekpo, Johnson.(1991). Chemistry laboratory safety skills and practices: Students' self-evaluation in selected secondary schools in Akwa, Ibom State. Indian Educational Review, Vol. 26(2): 107-15.

Ghose, A.M. (1990). Investigation on non-formal science education and development of inexpensive resource materials. Independent study. Visiting Scientist, Calcutta.

Ghosh,S (1984) A Critical Study of Science Aptitude and Attitude of Students and Determination of Determinants of Science Aptitude. Ph.D., Edn. Kalyan University.

Joshi, B.P. (1981) . Development of Science Education For Upper Primary Classes based on the Environmental Approach. S.I.E. Rajasthan.

Joshi,M.G. (1977). Content Analysis of General Science Textbooks for Standard 1V. College of Education. Jalgaon.

Joshi,M.G. (1979) . Development of an Edit Code for Evaluating Science text books. College Of Education .Jalgaon.

Koul, L. (1999) . Methodology of Educational Research . Vikas Publishing House Pvt. Ltd.

Malhotra, V.K. (1988). Critical Study of the Existing Facilities of Science Teaching and Construction of Evaluation Instruments for its Supervision in Different types of Secondary in India. Ph.D. Delhi University .

National Policy of Education -1968. New Delhi . Ministry of Human Resources Development.

National Policy of Education – 1986. New Delhi. Ministry of Human Resources Development.

Ramamurthy ,V.S. (1998). Science and Technology in National Development.' University News. Vol 36 . No. 16.

Rao, K.N. and Gupta (1990). Study of Science laboratories in Secondary Schools in Selected States. NCERT.(ERIC funded).

Raza, M. (1986). Educational Planning-A long term Perspective. NIEPA. New Delhi. Concept Publishing .

Sharma, H.L (1984) . A Critical Study of The Development of School Science Education in India from 1947 to 1977. Ph.D. Edn . Jamia Malia Islamia .

Sharma, Y.K. (1982). Growth and Development of Science Education in Bihar. Ph.d. Edn. Patna University.

Shukla, R. et.al (2005). India Science report: Science Education, Human Resources and Public Attitude towards Science and Technology. National Council of Applied Economic Research 2005. Parisila Bhawan, 11, Indraprastha Estate, New Delhi 110 002.

Sikka, P (1995). Science Policy In India .University News Vol 33. No. 36.

Veerapa, (1972-1978).as quoted in the Second Survey of Research in Education . NCERT.

Ghosh, Shibani. (1989). A critical study of scientific attitude and aptitude of the students and determination of some determinants of scientific attitude. Ph.D., Edu. Univ. of Kalyan.

Goel, V.P, and Agbebi, E.A.(1990). Learning physics through lecture-demonstration method (LDM) and individualised instruction method (II). Indian Educational Review, Vol. 25 (4): 84-89.

Gurumurthy, C. (1990). A comparative study of the effectiveness of guided discovery approach of doing physics experiments versus Instructed Performance Approach at pre-university level. Ph.D., Edu. Univ. of Mysore.

Javlekar, V.D. (1988). An investigation into the problem of evaluation of the educational importance of exhibits of Nehru Science Centre, Bombay, and its effectiveness in making children of Standard VIII understand scientific concepts. Ph.D., Edu. Univ.,of Bombay.

Kar, D ,K. (1990). A study of relationship between attitude towards and achievement in general science of Class IX students of Cuttack city.
Ph.D., Edu. Utkal Univ.

Kumar, Udaya Sam.(1991). The teaching of general science and the development of scientific attitude in secondary school students in relation to achievement in general science. M.Phil., Edu. Annamalai Univ.

Malhotra, V.K. (1988). A critical study of the existing facilities of science teaching and construction of evaluation instruments for its supervision in different types of secondary schools in Delhi. Ph.D., Edu. Univ. of Delhi.

Malik, Chander Kanta. 1990. A study of the impact of investigatory approach upon student-teachers' cognitive appraisal and its implications for Science Teachers' Training Programme. Ph.D., Edu. Maharashi Dayanand Univ.

Mamya, Dharma Shila. (1991). A study of attitude towards science and interest in science of school-going adolescents. Ph.D., Edu. Rani Durgavati Vishwavidyalaya.

Mandila, Shyam Singh. (1988). Attitudes of secondary stage students towards science curriculum and its relationship with achievement motivation. Ph.D., Edu. Univ. of Rqjasthan.

Mohanty, S.(1988). An appraisal of teaching science in the high schools of Cuttack City. Ph.D., Edu. Utkal Univ.

Mohapatra, J.K.(1989). Four dimensions of the teaching-learning of science: Characteristics and implications. Indian Educational Review. Vol. 24 (3): 1-17.

Nelliappan, N.O. (1992). A study of scientific attitude and interests among higher secondary biology students in relation to their learning environment. Ph.D., Edu. Annamalai Univ.

Pandit, B.L. (1989). Identification and measurement of chemistry laboratory skills of senior secondary school students of Delhi. Ph.D., Edu. The Maharaja Sayqjirao Univ. of Baroda.

Prakash, Brahma,(1990). Effectiveness of concrete materials to enhance learning in physical sciences. Independent study. National Council of Educational Research and Training.

Radhamonyamma. (1988). Evolving instructional techniques appropriate to the development of various scientific skills among secondary school pupils in Kerala. Ph.D., Edu. Univ. of Kerala.

Rao, Digumarti Bhaskara.(1990). A comparative study of scientific attitude, scientific aptitude and achievement in biology at secondary school level. Ph.D., Edu. Osmania Univ.

Rao, K.N. and Gupta, M.K.(1990). Study of science laboratories in secondary schools in selected states. Independent study. National Council of Educational Research and Training.

Rao, Shardamba. (1988). Explorations in optimising learning science in schools. Independent study. Karnataka: Office of the Field Advisor (NCERT).

Saxena, S.P. (1988). Sequential attainment of concept in chemistry through periodic table at the secondary stage. Independent study. Bhopal: Regional College of Education.

Sharma, Munishwar Kumar.(1990). A study of scientific literacy, attitudes towards science and personality traits of students and teachers. Ph.D., Edu. Univ. Of Rajasthan.

Shishta, Rama.(1990). An investigation into the effectiveness of guided discovery learning vis-a-vis the conventional approach to the teaching of scientific concepts in life sciences. Ph.D., Edu. JamiaMillia Islamia.

Shrivastava, Madhulika.(1988). An investigation into the scientific aptitude of higher secondary science students in relation to their cognitive style. Ph.D., Psy. Rani Durgavati Vis hwavidyalaya.

Sivadasan, K.R.(1988). Linking class teaching with science club programme in Kerala. Indian Educational Review, Vol. 23 (3): 156-64.

Srivastava, Veena.(1992). A study of creativity among higher secondary students in relation to scientific aptitude and attitude towards science. Ph.D., Edu. Agra Univ.

Sundararajan, S. (1988). An evaluation of the teaching of biology at higher secondary stage in Tamil Nadu. Ph.D., Edu. Annamalai Univ.

Vaidya, N.(1991). Developing teaching-learning strategies for enhancing student achievement in science. Independent study. National Council of Educational Research and Training.

Malsawmi, H.(2010). Progress and Expansion of Education in Mizoram- An Analysis. JP Offset Printers and Publishers, Aizawl, Mizoram.

SCERT (2004-2010). Annual Reports. State Council of Educational Research and Training, Mizoram, Aizawl-796012.

Lalhmuak et.al.(2000). Zoram Sikul Zirna Chanchin. Mission leh Kohhran Hnathawh. Lengchhawn Press, Bethel House, Khatla, Aizawl-796012.

Statistical Handbook of Mizoram (2010). Directorate of economics and Statistics; Government of Mizoram.

Rokhuma(1997). Mizoram Zirnaa Mission leh Kohhran Rawngbawlna.a Communications Department; Baptist Church of Mizoram.

Henn, M. et.al(2006). A Short Introduction to Social Research. Vistaar Publications. B-42 Panchsheel Enclave. New Delhi 110017

Mizoram University, Annual reports (2000-2010)

Appendix - 1

List of High Schools Selected as Sample

Sl. No.	Name	Management	District
1	Govt. K.M. High School	State Gov't.	Aizawl
2	Govt. Chaltlang High School	State Gov't.	Aizawl
3	Kendriya Vidhyalaya Aizawl	Central Gov't.	Aizawl
4	Govt. Mizo High School	State Gov't.	Aizawl
5	Govt. Pianghleia High School	State Gov't.	Aizawl
6	Synod higher Secondary School	Deficit	Aizawl
7	Govt. J.L.High School	State Gov't.	Aizawl
8	St. Paul's Higher Secondary School	Deficit	Aizawl
9	Holy Cross School	Deficit	Champhai
10	G.M. High School	State Gov't.	Champhai
11	King Solomon School	Private	Champhai
12	Hmar Veng High School	Private	Kolasib
13	Govt. Kolasib High School	State Gov't.	Kolasib
14	St. John Higher Secondary School	Deficit	Kolasib
15	Govt. Region Higher secondary School	State Gov't.	Lawngtlai
16	Downtown English School	Private	Lawngtlai
17	Chhimtlang Acadeny	Private	Lunglei
18	Govt. High School	State Gov't.	Lunglei
19	Baptist Higher Secondary School, Serkawn	Deficit	Lunglei
20	Mamit High School II	State Gov't.	Mamit
21	Mamit High school	State Gov't.	Mamit
22	E.C.M. High School	State Gov't.	Saiha
23	Don Bosco School	Deficit	Saiha
24	Govt. Serchhip High School	State Gov't.	Serchhip
25	Govt. P.C.R. High School	State Gov't.	Serchhip

Appendix - 2

List of Higher Secondary Schools Selected as Sample:

Sl.No.	Name	Management	District
1	Govt. Mizo Higher Secondary School	Gov’t.	Aizawl
2	Synod Higher Secondary School	Deficit	Aizawl
3	St. Paul’s Higher Secondary School	Deficit	Aizawl
4	Kendriya Vidyalaya	Central Gov’t.	Aizawl
5	Govt. K. M. Higher Secondary School	Gov’t.	Aizawl
6	Govt. Chaltlang Higher Secondary School	Gov’t.	Aizawl
7	Home Missions Higher Secondary school	Private	Aizawl
8	Oikos Higher Secondary School	Private	Aizawl
9	Govt. G.M. Higher Secondary School	Gov’t.	Champhai
10	St. John Higher Secondary School	Deficit	Kolasib
11	Govt. Higher Secondary School	Gov’t.	Lunglei
12	Baptist Higher Secondary School, Serkawn	Deficit	Lunglei
13	Don Bosco Higher Secondary School	Deficit	Saiha
14	Govt. Higher Secondary School	Gov’t.	Serchhip
15	Greenland Higher Secondary School	Private	Aizawl

Appendix - 3

Data sheet for Profile of Teachers:

Sl.No.	Name	Gender	Birth Date	Date of Entry into Service	Educational Qualification	Professional Degree (B.Ed) /Phd	Level Taught (HS/HSS/ College)	Management (Gov't./Private/ Deficit)	Subject taught
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Appendix – 4

Check list for Science Lab for High School

Name of School : ________________________________

I. PHYSICS

A. Apparatus and Equipment :-

Sl. No.	Particulars	Qnty.	Remarks
1	Concave mirror FL-15cm		
2	Convex mirror 5mm dia FL-10cm@FL20cm		
3	Plane miror, 10cmx5cmx3mm		
4	Convex lens plano FL10cm, FL50cm		
5	Glass Prisms(equilateral 40mmeach side)		
6	Glass slab(7.5x5x1.25cm)		
7	Slide callipers		
8	Rheostat		
9	Voltmetre DC with stand, 0-10 volts		
10	Ammeter with stand DC 0-5 MA		
11	Galvanometer, weston type		
12	Physical balance(dauble pan balance with glass case)		
13	Concave lens, plano 5cmm dia		
14	Bar magnet 100m length/alnico, 75mm length		
15	Horse shoe magnet		
16	Electromagnet		
17	Magnetic needle		
18	Metallic bob, pendulum bbob with hook		
19	Clinical thermometer		
20	Tuning fork-340hz, 480hz,256-512 hz		
21	Resistance wire, eureka constant 225 w		
22	Maximum and minimum thermometer		
23	Steel almirah 6x3		
24	Stop watches 0-60secx1/5 sec		
25	Tester,(electric)		
26	Multimeter(analogue)		
27	Battery eliminator		
28	Extension cord(ISI mark with indicator)		
29	Flexible wire (0.44mm copper)coil		
30	Experiment table, 6x4		

II. CHEMISTRY

A. Apparatus and Equipment :-

Sl. No.	Particulars	Qnty.	Remarks
1	Beakers borosil-500ml,250ml,100ml		
2	Conical flask borosil-250ml, 100ml		
3	Testtube borosil-20ml		
4	Glass funnel, big and small		
5	Glass rod-300mlx10mm(bundle of 50)		
6	Glass tube- 300x5mm(bundle of 50)		
7	Measuring cylinder, borosil glass upto 500ml		
8	Spirit lamp, brass, good quality, hard		
9	Tripod stand, triangular top iron 9mm		
10	Test tube holder, iron , good quality		
11	Test tube stand(plastic, at least 10 holdes)		
12	Weight box		
13	A pair of tongs		
14	Wire gauge, asbestos coated		
15	China dish, 70mm dia		
16	Dropper(5ml holder)		
17	Volumetric flask, borosil-500ml, 250ml		
18	Filter paper, standard quality		
19	Funne;l stand with ring clamp		
20	Ball and stick model, plastic set		
21	Hypodermic syringe, plastic-2ml holder		
22	Glass trough		
23	Beehhive shelf		
24	Gas jar		

B. Chemicals :-

Sl. No.	Particulars	Qnty.	Remarks
1	Colbaltous nitrate		
2	Anhydrous copper sulphate		
3	Common salt		
4	Ammonium chloride		
5	Acetic acid		
6	Ammonia soln		
7	Copper sulphate crystal		
8	Calcium carbonate		
9	Copper metal turning		

10	Fomaldehyde		
11	Ferrous suphate		
12	Ethyl alcohol absolute 99.9%		
13	Hydrogen peroxide		
14	Hydrochloric acid, concentrated		
15	Iron metal powder		
16	Iodine		
17	Magnesium sulphate		
18	Manganese dioxide		
19	Mercuric chloride		
20	Magnesium chloride		
21	Nitric acid, concentrate		
22	Pottasium chloride		
23	Pottasium permanganate		
24	Phenolpthalein		
25	Sodium bicarbonate		
26	Sodium carbonate		
27	Sodium nitrate		
28	Sodium hydroxide		
29	Sodium metal		
30	Starch soluble		
31	Silver nnitrate		
32	Sulphuric acid, concentrated		
33	Zinc sulphate		
34	Zinc chloride		
35	Zinc metal		
36	Zinc carbonate		

III. BIOLOGY

A. Apparatus and Equipment :-

Sl. No.	Particulars	Qnty.	Remarks
1	Mortar and pestle, medium size		
2	Pippette,borosil-10ml		
3	Dissecting tray(300mmx250mmx65mm-complete white enameledwith wax, good quality)		
4	Dissecting bbox(comprising 14 instruments, stainless steel-good quality)		
5	Compound microscope(standard quality eye piece 10x5 magnification 100x675 with box, lock and key)		
6	Simple/dissecting microscope(good quality)		

7	Hand lens(sample required)		
8	Glass slides box(13mmx108mmx38mm standard and index sheet with blue star)		
9	Cover slip(optically flat in log pack rectangular 20)blue star		
10	Permanent slides with labelled boxes		
11	Watch glass, heat proof, transparent and 60,80 diametre		
12	Charts- vitamins, food chain, food web		
13	Wide mouth bottle, good quality, 1000ml		

B. Charts :-

Sl. No.	Particulars	Qnty.	Remarks
1	Charts-Cell division (Mitosis & Meiosis)		
2	Plant Cell & Animal Cell		
3	Charts, Model, Diagrams, Specimen of Ancestral forms of Man, Canine & Incisors, Hands of Man & Monkey		
4	Chart/Diagram-Microscope (Compound & Simple)		
5	Chart-Human Heart, Reproductive System, Urinary System, Kidney Section		

C. Chemicals :-

Sl. No.	Particulars	Qnty	Remarks
1	Dpx mountant		
2	Conc.H CL		
3	Methylene blue		
4	Suffranine		
5	Iodine soln.		
6	Distilled water		
7	Conc. HNO3		
8	Ammonium hydroxide		
9	Burette reagent		
10	Millon's reagent		
11	Sudan III		
12	Formalin		
13	Eosine		
14	Ammonium chloride		
15	Cotton blue		
16	Zinc metal		
17	Marble chips		

Appendix – 5

Check list for science lab for Higher Secondary Education

Name of School : ____________________________________

I. PHYSICS

A. Apparatus and Equipment :-

Sl. No.	Particulars	Qnty	Remarks
1	Cylindrical Body (2.5 cm)		
2	Rectangular Block (Wooden)		
3	Vernier Callipers – Adjustable Steel		
4	Screw Gauge(Least count 0.001cm-Brass)		
5	Metallic Wire		
6	Spherical Ball with hook (Brass)		
7	Clamp Stand		
8	Resonance Tube (Brass)		
9	Rubber Pad/Cork-10,12,14,15,17mm bottom diameter		
10	Thermometer (half and one degree)		
11	Thermometer (maximum and minimum)		
12	Travelling Microscope		
13	Capitally Tube		
14	Searl's Apparatus		
15	Fortin's Barometer with enough mercury		
16	Helica's Spring up to 1 kilogram		
17	Metre Scale		
18	Crocodile Jaw (Clips)		
19	Soldering Reed (35 watt) and Soldering Pad		
20	Extension Cord		
21	Ammeter (0-500)MA, (0-1.5)A		
22	Voltmeter 0-3, 0-5, 0-10		
23	Meter Bridge (Complete with Jockey)		
24	Post Office Box		
25	Potentiometer (4 wire with Jockey)		
26	Resistance (diff. Ohm), Carbon Resistors		
27	Sonometer (AC) with slotted weight and hanger 0.5 kg		
28	Tangent Galvanometer (30-0.30-Moving coil type)		
29	Optical Bench (Steel-1 meter length,		

	double rod with 4 metal)		
30	Spherometer (0.55mm-Pitch-70-7 Scale)		
31	Glass Prism (Equilateral 25mm each side)		
32	Transistor PNP/NPN (AC 187)		
33	Illuminator		
34	Multimeter (Analogue)		
35	Spirit Level		
36	Zener Diodes/Diode		
37	Rheostat (Long)		
38	Daniel Gell		
39	Leclanche Cell		
40	Magnetic Compass		
41	Concave and Convex Lenses having short focal length		
42	Drawing Board		
43	Keys (Plug Keys-Reversing Keys)		
44	Lead Acid Accumulators/Rechargeable(0-6 volt)		
45	Step Up/Down Transformer		
46	Light Emitting Diode (LED)		
47	L.D.R		
48	Wrench Box		
49	Self Adjusting Cutter		
50	Striper (MT-02)		
51	Stabilizer (manual)		
52	Tester Set		

II. CHEMISTRY

B. Apparatus and Equipment :-

Sl. No.	Particulars	Qnty.	Remarks
1	Burette (Torson) – 50ml (Plastic)		
2	Beakers-500ml, 250ml, 100ml		
3	Conical flask-250ml,100ml		
4	Pipette		
5	Test tube-10ml,20ml,		
6	Reagent Bottle-1000ml,250ml,500ml		
7	Funnel(small size glass)		
8	Glass rod-300x10mm-4mm dia.		
9	Glass tube-300x5mm		
10	Volumetric Flask-1000ml,500ml,250ml		
11	Almirah , wooden 3x6 ft		
12	Water tanky, syntex-2000lt, export quality		

13	Burette stand,plastic		
14	Tripod stand(triangular iron top-9mm)		
15	Blow pipe, metallic standard		
16	Cork borer(set of 6 standard-iron)		
17	Wire gauge(asbestos coated)		
18	China dish(porcelain dish-70mm dia)		
19	Mortar and pestle(porcelain)		
20	Test Tubebrush(good quality)		
21	Burette Brush(galvanised wire with handle)		
22	Wash Botle(plastic LD, good quality with nozzle)		
23	Platinum wire embodied in glass rod		
24	Hot plate(good quality)		
25	Hot water bath(good quality with at least 8 holes)		
26	Spatula(iron)		
27	Filter paper(watman's)		
28	Refridgerator		
29	Electric balance		
30	Universal indicators(solution or paper)		
31	pH paper		
32	Measuring cylinder		
33	-10ml,50ml,100mml,500ml		
34	Long form of periodic taable		
35	Watch glass(big size glass)		
36	Thermometer 100degrees celsius and above, plastic		
37	Overhead projector		
38	Bunsen burner		

C. Chemicals :-

Sl. No.	Particulars	Qnty.	Remarks
1	Ammonium Molybdate		
2	Ammonium Carbonate (Purified or AR)		
3	Ammonium Chloride AR		
4	Ammonium Sulphate AR		
5	Ammonium nitrate AR		
6	Ammonium phosphate		
7	Ammonium ferrous sulphate AR		
8	Ammonium ceric nitrate AR		
9	Ammonium oxalate AR		
10	Ammonium thiosyanide AR		
11	Ammonium acetate AR		

12	Ammonium sulphide		
13	Aluminium nitrate AR		
14	Aluminium chloride(hydrated AR)		
15	Aluminium sulphate AR		
16	Acetic Acid(glacial AR)		
17	Aniline AR		
18	Acetone (EL)		
19	Acetanilide		
20	Acetaldehyde soln.		
21	Ammonia soln.		
22	Bromide water(AR 5x20ml)		
23	Barium nitrate AR		
24	Barium chloride AR		
25	Bariumcarbonite AR		
26	Benzoic acid AR		
27	Benzaldehyde AR		
28	Benzene Ar		
29	Boric acid(crystals AR)		
30	Benzene crystallizable		
31	Barium sulphate AR		
32	Copper sulphate(crystals, soln)		
33	Cupric carbonate		
34	Cupric chloride AR		
35	Cupric nitrate		
36	Calcium chloride dihydride AR		
37	Calcium sulphate dihydrude AR		
38	Calcium oxide lumps AR		
39	Calcium tetrahydride AR		
40	Calcium carbonate		
41	Carbon di sulphide AR		
42	Cadmium sulphate AR		
43	Cadmium chloride		
44	Carbon tetrachloride AR		
45	Copper metal turning		
46	Chloroform, AR/dry AR		
47	Cobalt nitrate		
48	Charcoal block, activated charcoal AR		
49	Dimethyl glyoxime AR		
50	Disodium hydrogen phosphate		
51	Diethyle ether AR		
52	2,4 dinitrophenyl hydrazine		
53	Formaldehyde(diethyl acetal AR)		
54	Ferrous sulphide		
55	Ferrous sulphate AR		
56	Fehlings soln A		
57	Fehlings soln B		
58	Ferric chloride		

59	Ferric nitrate AR		
60	Ethyl alcohol absolute 99.9% omnis		
61	Glycerol-glycerine AR		
62	Hydrogen peroxide		
63	Hydrochloric acid		
64	Iron metal powder		
65	Iodine resublimed		
66	Lead dioxide or peroxide		
67	Lead acetae AR		
68	Lead bromide		
69	Lead nitrate		
70	Lead chloride		
71	Manganous sulphate		
72	Magnesium sulphate		
73	Manganese dioxide		
74	Mercury metal		
75	Mercuric chloride		
76	Mercurous nitrate		
77	Methanol		
78	Methyl orange		
79	Manganous chloride		
80	Mercuric nitrite		
81	Magnesium chloride		
82	Nickel chloride		
83	Nickel sulphate		
84	1 napthol		
85	2 napthol		
86	M nitrobenzene		
87	Ninhydrine		
88	Nessler’s reagent		
89	Nittric acid		
90	Oxalic acid		
91	Potassium chloride		
92	Potassium hydroxide		
93	Potassium iodide		
94	Potassium dichromide		
95	Potassium chromate		
96	Potassium nitrate		
97	Potassium carbonate		
98	Potassium ferricyanide		
99	Potassium sulphocyanide		
100	Potassium pyroantimonate		
101	Potassiumferrocyanide		
102	Potassiumthiocyanide		
103	Picric acid		
104	Phenolpthalein		
105	Pathallic anhydride		

106	Sodium bicarbonate		
107	Sodium carbonate		
108	Sodium sulphide		
109	Sodium bromide		
110	Sodium acetate		
111	Sodium iodide		
112	Sodiumnitrate		
113	Sodium hydroxide		
114	Sodium nitroprusside		
115	Sodium chloride		
116	Sodium sulphate		
117	Sodium bisulphate		
118	Sodium thiosulphate		
119	Sodium metal		
120	Salicylic acid		
121	Stannous chloride		
122	Starch soluble		
123	Strontium chloride		
124	Schiff's powder		
125	Sulpher powder		
126	Silver nitrate		
127	Sulphuric acid		
128	Sodium sulphite		
129	Strontium nitrate		
130	Sodium bisulphate		
131	Urea		
132	Universal indicator(soln or paper)		
133	Xylene		
134	Zinc sulphate		
135	Zinc chloride		
136	Zinc metal		
137	Zinc carbonate		
138	Zinc nitrate		
139	Sodium citrate		
140	Atomic model set		
141	Pottassium hydrogen sulphide		
142	Pottassium bromide		
143	Pottassium sulphocyamide		
144	Nickel carbonate		
145	Cobalt acetate		
146	Magnesium acetate		
147	Magnesium nitrate		
148	Cobalt chloride		
149	Sodium cobalt nitrate		
150	Thiourea		
151	Litmus blue(solid)		
152	Diethyl amine		

153	Pottassium permanganate		
154	pH paper		
155	Spirit		
156	Furfugal soln.		
157	Citric acid		
158	Acetyl chloride		
159	Benzyne sulphonyl chloride		
160	Phenol		
161	Lucas reagent		
162	Tollen’s reagent		

III. BIOLOGY

A. Apparatus and Equipment :-

Sl. No.	Particulars	Qnty.	Remarks
1	Incubator		
2	B.O.D. Bottles		
3	Burette Stand (Plastic-White)		
4	Centrifugator		
5	Bell Jar		
6	Dryer (Phillips)		
7	Cotton Wool		
8	Filter Paper		
9	Ph Meter		
10	Gas Connection		
11	Dissecting Tray (300mm x 250mm x 65mm - Complete white enameled complete with wax- good quality)		
12	Dissecting Set(Comprising 14 instruments, stainless steel–good quality)		
13	Compound Microscope (Standard quality eye piece x 10 x 15 (noth mygenian) magnification 100 x 675 x with bx, lock and key - good quality)		
14	Simple Microscope (Good quality)		
15	Slides (In box-25 slides size 130mm x 108mm, 38mm standard with index sheet)		
16	Cover Slips (Circular)		
17	Petri Dish (100mm x 15mm depth)		
18	Cancet		
19	Test Tube Stand (At least 10 holders)		
20	Crucible		
21	Droppers – 5ml		
22	Wide Mouth Bottles – 1000ml		

23	Maximum & Minimum Thermometer (Dimple Brand)		
24	Hammer (Small- good quality)		
25	Rubber Stopper fit for 10, 20, 30mm diameter		
26	Pipette – 5ml, 10ml, 20ml		
27	Lab Stand Set		
28	Test Tubes – 20ml, 50ml (Hard Glass)		
29	Test Tube Holder (Iron – good quality) set		

B. Chemicals :-

Sl. No.	Particulars	Qnty.	Remarks
1	Aceto-Carmine		
2	Carmine MS		
3	Iodine Pellets		
4	Starch- Powder		
5	Leishman'n Stain		
6	Sucrose Powder		
7	Glucose Powder		
8	Benedict's Reagent		
9	Sulphosalicylic Acid		

C. Permanent Slides :-

Sl. No.	Particulars	Qnty.	Remarks
1	T.S. of Nerve Cells		
2	T.S. of Hydra		
3	Mitosis Cell Division (All Stages)		
4	Meiosis Cell Division (All Stages)		
5	Human Blood Smear		
6	Frog Blood Smear		
7	Striated Muscles		
8	Un-striated Muscles		
9	Cardiac Muscles		
10	Squamous Epithelium		
11	T.S. of Dicot Stem		
12	T.S. of Monocot Stem		
13	T.S. of Dicot Root		
14	T.S. of Monocot Root		
15	Bacteria		
16	Leaf Stomata		
17	Sclerenchyma, Parenchyma, Xylems, Phloem, Nostoc, Spirogyra, Oscillatorin, Rhizopus, Anabourn		

18	Amoeba		
19	Paramecium		
20	Euglena		

D. Specimens :-

Sl. No.	Particulars	Qnty.	Remarks
1	Mosses		
2	Fern Plant		
3	Pitcher Plant		
4	Mildew		
5	Rust		
6	Smut		
7	Potato Blight		
8	Life Cycle of Silk Moth		
9	Life Cycle of Frog		
10	Life Cycle of Honey Bee		
11	Life Cycle of House Fly		
12	Life Cycle of Butterfly		
13	Root Nodules of Legumes		
14	Liverworts		
15	Rhizobium		
16	Fungi (Mushroom)		
17	Cuscuta		
18	Hydrilla		
19	Drocera		
20	Cactus		
21	Euphorbia		
22	Fishes - Shark, Rohu, Anabus, Catla, Common Carp, Grass Carp		
23	Salamander		
24	Toad		
25	Snakes, Lizards, Tortoise, Octopus		
26	Octopus		
27	Torpedo		
28	Pigeon, Parrot, Sparrow		
29	Rat, Rabbit		

E. Charts :-

Sl. No.	Particulars	Qnty.	Remarks
1	Cell Division (Mitosis & Meiosis) – Different Stages		

2	Biogeochemical Cycles (Nitrogen, Co_2, O_2, Phosphorous, Sulphur)		
3	T.S. of Stem – Dicot and Monocot		
4	T.S. of Root – Dicot and Monocot		
5	Secondary Growth of Dicot and Monocot Stem		
6	Plant Cell and Animal Cell		
7	Classification of Animal Kingdom		
8	Classification of Plant Kingdom		
9	Internal Structure of Heart, Kidney, Lungs and Ovary		
10	Different Types of Tissue Systems (Animal & Plant)		
11	Respiratory System, Reproductive System, Circulatory System, Skeletal System, Excretory System and Muscular System of Man		
12	Cell Organelles (Mitochondria, Nucleus, Chloroplast, Cell Wall, Ribosomes, Endoplasmic Recticulum, Golgi Body, Cilia, Flagella, Centriole, Plasma Membrane, Plastids)		
13	Life Cycle of Frog, Silk Moth, Mushroom, Fern, Moss, Rhizopus, House Fly, Butterfly		
14	Infloresence (Different types)		
15	Digestive System of Human Beings		
16	Floral Parts (China Rose, Mustard)		
17	Structure of Human Brain		
18	Models of DNA		
19	Models of RNA		

F. Furnitures :-

Sl. No.	Particulars	Qnty.	Remarks
1	Steel Almirah (Big- Godrej)		
2	Towels		
3	Wooden Stools (3ft Height)		
4	White Board		
5	Practical Tables (6ft x 3 ft – Wooden)		
6	Table with Chair (Wooden)		
7	Wooden Almira (6ft x 3ft)		
8	Buckets (Big-Plastic)		
9	Plastic Mugs (Big)		

Appendix – 6

Interview Schedule
(For Science Teachers)

1. Name of college/ school: ________________________.
2. Date of establishment: _______________________.
3. Date of affiliation: ______________________________________.
4. Date of attaining deficit status: ________________.
5. Date of provincialization: ______________________.
6. Date of opening science stream: ______________________________.
7. Date of affiliation of science stream/ subject: ____________________.
8. Number of science subjects offered: ___________________________.
9. Number of science teachers in each science subject: ______________.
10. Number of science teachers who are regular: ___________________.
11. Number of science teachers who are on contract basis: __________________.
12. How many practical classes does each class have in a week: ____________________.
13. How many laboratory attendants are present: _________________________.
14. How many laboratory bearers are present: ____________________.
15. Does the college/school have a proper building for a laboratory for each subject: __________________.
16. How many students are present in each class from first year to third year(for colleges):

    1st year________

    2nd year_________

    3rd year________.

17. How many students are present from Class XI to XII(Higher Secondary Schools):

    Class XI_______.

    Class XII______.

18. How many students are present from classes VII to X(High Schools):

Class VIII_______.

Class IX________.

Class X_________.

19. Is practical work carried out according to your time table?_______.
20. Does the college/school have adequate laboratory practical equipment:______________.
21. Who gives the financial allocations for the laboratory equipment: _________________.