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RESEARCH ARTICLE

Analysis of High School Leaving Certificate (HSLC) Examination from the year 1978–2021 under Mizoram Board of School Education with a special focus on Mathematics subject and forecasting male and female percentages using time series analysis

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Mathematics is regarded as the hardest subject in school education in Mizoram. Students always have a sense of fear and failure. Though many attempts were made by various Science Societies and the government of Mizoram to overcome this, the performance of the candidates for High School Leaving Certificate (HSLC) and Higher Secondary School Leaving Certificate (HSSLC) Examinations under Mizoram Board of School Education (MBSE) proved that it is still the subject performed worst compared to other subjects. It was also observed that the correlation coefficient of Mathematics is highest with science subjects in the HSLC Examination from 1978 to 2021, which is positive and also significant at 1% and 5% levels of significance indicating that if the score of science subject increases the score of mathematics subject will also be increased among the students. The highest regression coefficient was also observed in science with 0.530, which means that if the score in science increase by one mark, the mathematics score will be increased by 0.530 marks. From time series analysis from 1978 to 2021 using ARIMA, it was also observed that female candidates will have a higher pass percentage as compared to male candidates in the next five years i.e. 2022 to 2026; it will be very challenging for male candidates.

Keywords : Matriculation, Mean, Score, Correlation and Regression, Mizoram

Introduction

Formal education in Mizoram started with the arrival of Christian Missionaries. The Christian Missionaries introduced the Roman scripts in 1894 with a phonetic form of spelling. The first government school was started in 1897 at Aizawl. For more than half a century, i.e. from 1895 to 1952, elementary education was looked after by Christian mission through the Honorary Inspector of Schools. During the period between 1953 and 1972, the management of Primary Education was in the hand of the District Council. When Mizoram became Union Territory in 1972, the administration and management of elementary education, i.e. Primary and Middle School was transferred to the government.[1]

Mathematics was included under the Science umbrella in Mizoram (Telephone Interview with former Director of Education, Dr. L.N. Tluanga on 15.09.2021, 11:36 AM). Prior to 1973, Science was taught in Middle schools as General Knowledge

dealing mainly with Biological Sciences. Science subject was made optional in High Schools and only a few students took Science in High Schools and Colleges. Science Education in its true sense began only in 1973, when the UNICEF-assisted Science Education programme was launched after the Government of the Union Territory of Mizoram signed a bond with the Government of India accepting the introduction of Science in 50 Primary and 30 Middle Schools. A new and separate wing for Science promotion (Now called Science and Mathematics Promotion Wing under SCERT) was created in the Education Department in 1973. A Science Promotion Officer and Science Consultants were appointed to look after and man the pilot project in Science and Mathematics Education. An Academic Officer for Science has also been appointed in the Mizoram Board of School Education, which was established in 1976.[2]

Matriculation Certificate, also called the High School Leaving Certificate is a certificate awarded to students who have cleared their class 10 or 10th grade examinations. Many countries around the world have their own set of examinations for class 10 or higher. In India, this examination is conducted by various boards - such as the CBSE, ICSE and State Boards. Matriculation examinations are one of the most important exams in India. The term matriculation has been borrowed since the days of British rule in India. In England, the term matriculation is now replaced with the "O" Level or the Ordinary Level Examination. English is the standard language for matriculation for science subjects, while regional languages are also an option. Most students who pass matriculation or class 10 are 15–16 years old. Upon successfully passing, a student may continue their senior secondary school. Most students who pass class 12 are 17–18 years old.

The Mizoram Board of School Education was established in 1975 by the MBSE Act. The act was approved by the Legislative Assembly of the Mizoram Union Territory, at that time the administrative head was the Chief Minister Ch. Chhunga. The board, as an autonomous authority in education, started functioning on 2nd December 1976. It has the power to regulate, supervise and control school education in Mizoram. Its primary function is to prepare academic programs and organize examinations, especially for state-level HSLC and HSSLC. The first HSLC examination was conducted by MBSE in 1978.[3]

Mathematics education is a vital concern although only limited research is available for studying this topic, particularly in Mizoram. It is the root of all sciences and technical education, and it also has its own merit in real life. However, there is a general opinion even among the intellectual circle in Mizoram that Mathematics subject is the backlog for many students to succeed in academics convincing themselves that one can succeed in life without Mathematics at the secondary level. The 63rd meeting of the Syllabus and Textbook Committee of MBSE held on 5th July, 2011 in its resolution No SC:63:2011:06 decided that two levels i.e. Group A and Group B be introduced in classes IX and X, whereby only those students who opt for Group A Mathematics would be eligible for Science stream when pursuing higher studies. This was felt important because there are a number of students failing in the subject or who barely managed to make it through HSLC, but never have any link with Mathematics for their further studies. In short, there are many successful people who still dread the subject.[4]

Although the Education Commission of 1964 recommended that Mathematics should be taught as a compulsory subject of general education up to class X,[5] experiences and data have shown that the majority of students normally failed in this subject. This frustrates not only students but also parents. Many educationists feel that Mathematics should be compulsory up to class VIII, while some opine that there should be two types of Mathematics courses at the secondary level, and these courses should be need-based. Central Board of Secondary Education (CBSE) has decided to introduce two levels of examination in Mathematics for the students who are going to appear in the Board examination for the academic session ending March 2020 onwards. One will be known as Mathematics - Standard for the existing level of examination, and the other will be known as Mathematics - Basic for the easier level of the exam (for students who do not want to study Math in the future).[6]

NCERT[7] identified that there is a sense of fear and failure regarding mathematics among a majority of children and there is a lack of support in the teaching of mathematics. The paper stated "By Class III or IV, many children start seeing themselves as unable to cope with the demands made by mathematics. In high school, among children who fail only in one or two subjects in year-end examinations and hence are detained, the maximum numbers fail in mathematics. This statistic pursues us right through to Class X, which is when the Indian state issues a certificate of education to a student. The largest numbers of Board Exam failures also happen in mathematics".

It was found out that secondary school students' performance in Mathematics has been consistently poor and suggested that more research needs to be taken up for finding out the problems of students with regards to Mathematics, more efforts are given to the development of mathematics education and the state government needs to pay special attention for the development of mathematics education.[8]

Methods

The present research is mainly descriptive in

nature. Quantitative approaches have been applied. In this study, the researcher wants to prove the general concept that performance in Mathematics is worst compared to other subjects. For this, the percentage and mean of the score of each subject were calculated using excel software for each examination. For Correlation and Regression analysis and time series analysis, SPSS 20 was employed.

Population and sample

No sampling was done in this study. The result of the HSLC examination from 1978 to 2021 was obtained from the MBSE office. The result of the last twelve years HSSLC (Science) examination from 2009 to 2021 was obtained from the MBSE office. Only the main examinations were considered, so, special examinations and compartmental examinations conducted by MBSE were not included in this study.

Data collection

The Mark score of each and every candidate was requested by the researcher to the MBSE authority. The MBSE authority agreed to provide the score of each candidate, excluding personal details like names, Roll No, Date of birth etc. Soft copies of the data in excel format were sent to the researcher through email.

Results and Discussion

Figure 1 shows the pass percentage of HSLC main examinations (excluding special, supplementary and compartmental examinations). From 1978 to 2006, the pass percentage is below 50%, which means that more than half of the candidates did not pass the

HSLC examination. It was generally said that these failures are mainly due to Mathematics subject. From 2007, we can see a new trend, the pass percentage increased gradually and it was always above 50%. In the 2021 HSLC examination, the pass percentage was 82.43%, which is the first time it was more than 80%. This may be due to the reduction of the course by 30% from the full syllabus due to covid-19 pandemic. From 2008 onwards, the pass percentage is above 60% except in 2013.

From figure 2, it can be seen that out of 43 HSLC examinations conducted by MBSE since its inception, the mean score of HSLC candidates is lowest compared to other subjects in 35 examinations, Social Studies in 5 examinations, Science in 1 examination and English in 2 examinations. This shows that the Mathematics score of the candidates is lowest in almost all the HSLC Examinations conducted from 1978 to 2021.

From figure 3, it can be found that out of 43 HSLC Examinations conducted by MBSE so far, the pass percentage of HSLC candidates in Mathematics subject is lowest compared to other subjects in 31 examinations, Social studies in 6 examinations and Science subject pass percentage is also the lowest in 6 examinations.

Subject-wise performance of students in HSSLC (Science) Examinations

The score of candidates in HSSLC (Science) was obtained from MBSE. To find the mean score, all the scores in each subject were summed up using Excel software and then divided by the number of candidates who appeared in the exam to obtain the mean score. The pass percentage in each subject
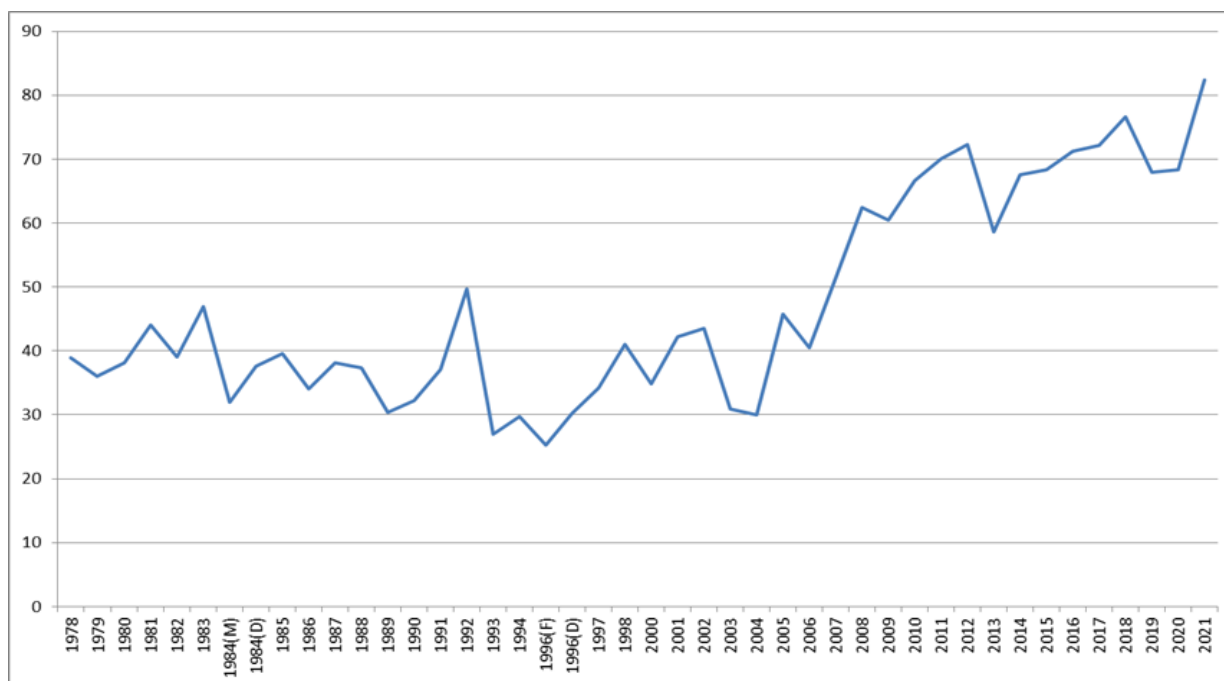

Figure 1: Pass percentage of HSLC examinations under MBSE from 1978-2021
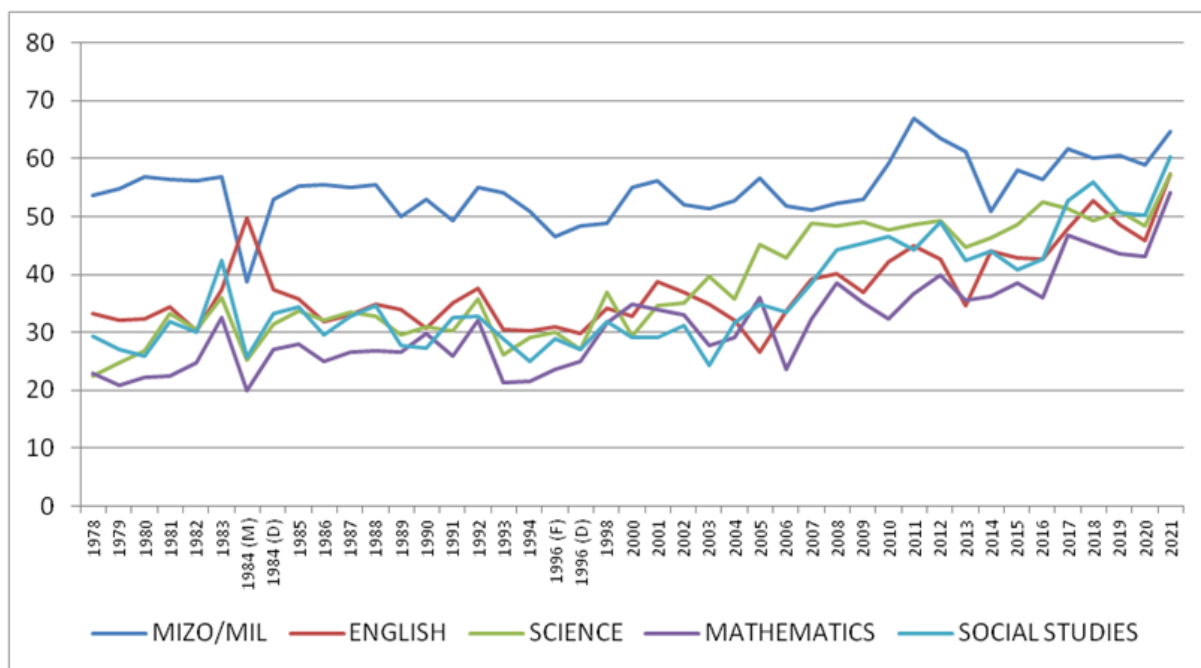
Figure 2: Subject-wise mean score of HSLC candidates under MBSE from 1978-2021
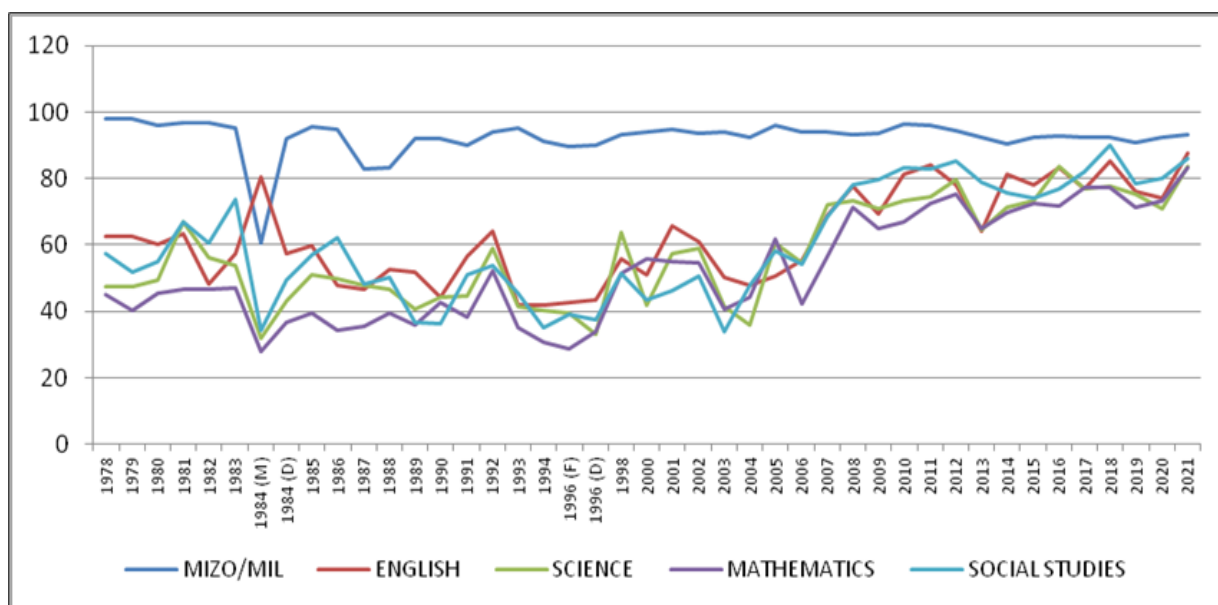
Figure 3: Subject-wise pass percentage of HSLC candidates under MBSE from 1978-2021
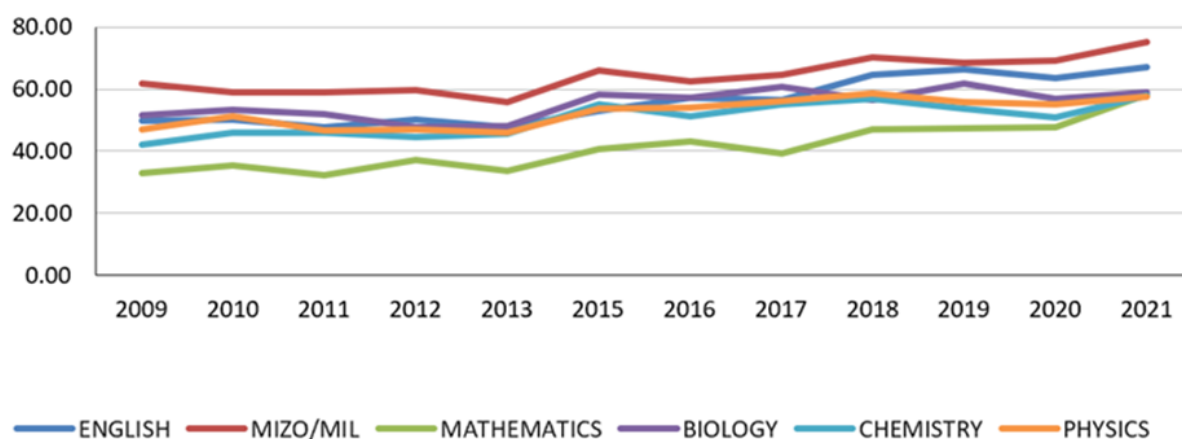
Figure 4: Subject-wise mean score of HSSLC(Science) from 2009-2021

Table 1: Correlation coefficient between subjects

Subjects		Mathematics	English	Science	Social science	Modern Indian Language
Mathematics	Correlation coefficient	1	.675**	.796**	.717**	.526**
	p-value		<0.0001	<0.0001	<0.0001	<0.0001
	N	408435	408435	408435	408435	408435
English	Correlation coefficient	.675**	1	.720**	.712**	.630**
	p-value	<0.0001		<0.0001	<0.0001	<0.0001
	N	408435	408435	408435	408435	408435
Science	Correlation coefficient	.796**	.720**	1	.792**	.534**
	p-value	<0.0001	<0.0001		<0.0001	<0.0001
	N	408435	408435	408435	408435	408435
Social science	Correlation coefficient	.717**	.712**	.792**	1	.506**
	p-value	<0.0001	<0.0001	<0.0001		<0.0001
	N	408435	408435	408435	408435	408435
Modern Indian Language	Correlation coefficient	.526**	.630**	.534**	.506**	1
	p-value	<0.0001	<0.0001	<0.0001	<0.0001	
	N	408435	408435	408435	408435	408435
**. Correlation is significant at the 0.01 level (2-tailed).						

Figure 5: Subject-wise pass percentage of HSSLC (Science) from 2009-2021

was calculated by counting the number of passes in each subject as per pass marks of the subject and using the number of candidates who appeared in that particular subject.

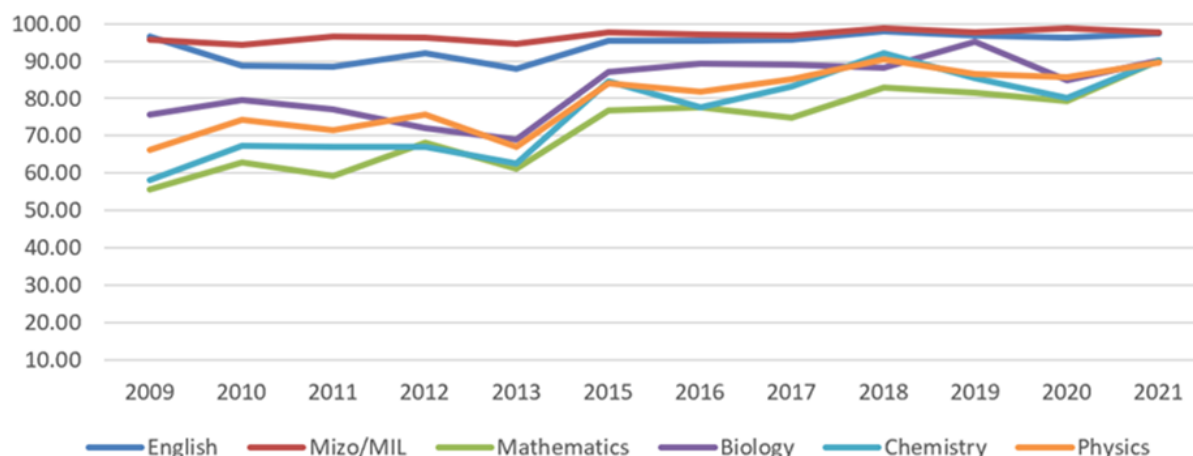From Figure 4, it can be seen that out of 12 HSSLC (Science) Examinations conducted by MBSE, the mean score of candidates is lowest compared to other subjects in all the examinations, except one year.

This shows that the Mathematics score of the candidates is the lowest in almost all the HSSLC (Science) Examination conducted so far.

From Figure 5, it can be seen that out of the last 12 HSSLC (Science) Examinations conducted by MBSE, the pass percentage of candidates in Mathematics is lowest compared to other subjects in almost all the examinations.

The degrees of relationship between subjects are calculated by using the Pearson correlation coefficient, which is given in Table 1. For

Table 2: Regression Analysis

Variables	β	SE	t	p-values	95% Confidence interval for β		R^2	R^2 Adjusted
					Lower	Upper		
(Constant/ Intercept)	-10.806	0.113	-95.395	<0.0001	-11.028	-10.584		
Science	0.530	0.002	289.935	<0.0001	.527	.534		
Social science	0.171	0.002	113.271	<0.0001	.168	.174	0.673	0.673
English	0.130	0.001	88.052	<0.0001	.127	.133		
Mizo	0.103	0.001	92.245	<0.0001	.101	.106		
Gender	-0.081	0.044	-1.836	<0.066	-.167	.005		
Years	0.183	0.002	74.186	<0.0001	.178	.188		

Table 3: Regression Analysis using Stepwise method

Model	Variables	β	SE	t	p-values	95% Confidence interval for β	
						Lower	Upper
1	(Constant)	-.471	.055	-8.573	.000	-.579	-.364
	Science	.862	.001	840.369	.000	.860	.865
2	(Constant)	-2.673	.055	-48.548	.000	-2.781	-2.565
	Science	.697	.001	486.525	.000	.694	.700
	English	.210	.001	160.297	.000	.207	.213
3	(Constant)	-3.082	.054	-56.624	.000	-3.188	-2.975
	Science	.590	.002	341.992	.000	.587	.594
	English	.161	.001	117.176	.000	.158	.163
	Social science	.164	.002	107.859	.000	.161	.167
4	(Constant)	-5.165	.062	-82.896	.000	-5.287	-5.043
	Science	.578	.002	334.465	.000	.574	.581
	English	.121	.001	82.010	.000	.119	.124
	Social science	.161	.002	106.734	.000	.158	.164
	Mizo	.068	.001	67.483	.000	.066	.070
5	(Constant)	-10.908	.099	-110.310	.000	-11.102	-10.714
	Science	.531	.002	290.210	.000	.527	.534
	English	.130	.001	88.070	.000	.127	.133
	Social science	.171	.002	113.522	.000	.168	.174
	Mizo	.103	.001	92.946	.000	.101	.105
	Years	.183	.002	74.464	.000	.178	.187

Table 4: Forecast with 95% prediction intervals for the pass percentage of male candidates in HSLC after fitting ARIMA(0,1,1) Model from 1978-2021

Gender	Year	Forecast (Pass percentage)	95% Confidence interval	
			Lower	Upper
Male	2022	73.33	54.95	95.82
	2023	75.38	51.73	99.04
	2024	75.38	48.90	101.87
	2025	75.38	46.35	104.42
	2026	75.38	44.01	106.77
Female	2022	77.57	61.80	93.34
	2023	78.74	61.48	96.00
	2024	79.90	61.27	98.53
	2025	81.07	61.16	100.97
	2026	82.23	61.13	103.33

Mathematics subject, it is observed that the correlation coefficient is highest with the Science subject (i.e. 0.796), which is positive and also significant at 1% and 5% levels of significance indicating that if the score of the science subject increases the score of mathematics subject will also be increased among the students. The smallest correlation coefficient was observed between Mathematics subject and Major Indian Languages with a value of 0.526 indicating that among all the major subjects, which has the least impact on scoring higher marks in Mathematics. For the English subject, the highest correlation coefficient observed with the science subject indicates that if the English score increase, the science score will also be increased. For social science, the highest correlation coefficient observed with science subjects with a value of 0.792, indicates that an increase in science scores will result in an increase in social science also. But, for the English subject, the correlation coefficient is highest with MIL, indicating that the two languages are highly correlated. Generally, if they score good marks in English, they have the chance to get good marks in other language subjects also.

Regression analysis is also used to find the relationship between Mathematics and other subjects, which is given in Table 2. The highest regression coefficient observed in science with 0.530, which means that if the score of science increase by one mark, the mathematics score will be increased by 0.530 marks.

The other significant variables which are contributing to the increase in Mathematics scores are years, social science subjects, English and Mizo. However, gender is not significant for the score in mathematics mark. The value of the coefficient of determination (R^2) is also obtained and it is 0.673

indicating that subjects of science, social science, English, Mizo, gender and years account for 67.3% of the total variation in mathematics marks. This means 32.7% is not accounted for by other subjects, gender and years. This may be due to some other unknown factors related to studies.

Table 3 shows the regression analysis by the stepwise method. In the table, estimated coefficients (β) of covariates, standard error of β estimates (SE), test statistic values, p-values and 95% confidence interval are shown. In the first step, Science is entered into the model and selected as the most important covariate out of 6 variables. In the second step, in addition to Science, English is entered into the model. In the third step, social science was added to science and English. In the fourth step, Mizo was added to the science, English and social science, and in the last step, science, English, social science, Mizo and years are entered into the model. These five covariates comprise the best set of covariates which can explain the score of mathematics.

Forecasting male and female pass percentage

The model ARIMA (0,1,1) is fitted to our time series using SPSS 20 software. After the most appropriate model has been defined in our case, forecasting has to be made, to do this and so to predict trends and develop forecasts, the IBM SPSS Forecasting is used. Table 4 presents the forecast values of the pass percentage of male and female candidates in HSLC by applying our model ARIMA (0,1,1) for the next 5 years.

A time series analysis of the results of appeared candidates in the matriculation/HSLC Examination in Mizoram from 1987-2021 has been done by the Box-Jenkins ARIMA model.

From the analysis, it is found that ARIMA (0,1,1) model is the best fit model for male and female candidates respectively in our study. Firstly our raw data are differenced to eliminate non-stationary (Dickey-Fuller = -2.2172,-2.0008 and p-value = 0.4878, 0.5735 for male and female respectively) and confirmed stationary by performing ACF and PACF Plot of differenced data and also performed Dickey-Fuller test.

It is found that Dickey-Fuller = -4.1656, -3.7631 with p-value = 0.01231, 0.03171 for male and female respectively, therefore the null hypothesis of non-stationary is rejected and then it can be concluded that the time series data is stationary. Then the parameter is estimated and after that Diagnostic test is performed followed by residual analysis. Then the pass percentage of both male and female candidates in the HSLC Examination for the next five years namely 2022, 2023, 2024, 2025 and 2026 is forecasted respectively along with their 95% prediction interval.

The corresponding forecasted pass percentage for males is 73.33 with 95% lower and upper prediction limits of 54.95 and 95.82 respectively and the pass percentage for the female is 77.57 with 95% lower and upper prediction limits of 61.80 and 93.34 respectively.

It is also observed that female candidates will have a higher pass percentage as compared to male candidates in the next five years; it will be very challenging for male candidates.

In a time series generated by a stochastic process, it is not always possible to exactly predict the output of the process in the future.[9]

Conclusion

It was observed that the performance of candidates in Mathematics is worst in HSLC and HSSLC examinations conducted by MBSE. Since there is no Board examination up to class 9, the same trend seems to happen in lower classes also. So, It is a great concern to society as a whole to improve the teaching-learning of Mathematics to achieve a greater result and better understanding of the mathematical concept. In order to improve mathematics education in Mizoram, urgent steps are needed to be taken. The findings of the present research work are expected to be of much value to all stakeholders of education, especially in secondary education. These data analyses and findings will be of extreme importance to teachers, policymakers, administrators, examination boards and syllabus framers alike.

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