CHAPTER -III

RESEARCH METHODOLOGY

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This chapter presents an overview of the study's research methodology and describes the study's design, population, sample, sampling technique, data collection tools, data collection procedure, data analysis techniques, and pilot study of data collection tools.

3.1 Research Method

This study has a descriptive method in which data is collected based on a large number of samples, at a time, to interpret and analyze the current condition. For the assessment of the predictive power of independent variables and the relationship between dependent and independent factors, a correlational research method was employed (Creswell, 2012). Here, students' academic performance in the physics course served as the dependent variable. The study was based on a correlational design in which school climate, scientific thinking, parental autonomy support, and procrastination tendency were each examined for their impact on students' academic achievement.

3.2 Study Area

Himachal Pradesh is known for its wide range of geographical diversity and rough topography, with the majestic Himalayan ranges dominating its landscape. It extends between the latitudes 30°22' and 33°12' North and between the longitudes 76°44' and 79°03' East, with an area of about 55,538 km (Himachal Pradesh State Government, 2024). He has a population of about 7.5 million reported in the 2011 Census, making it one of the smaller states in terms of population (Census of India, 2011). Himachal Pradesh has a low population density, of just over 148 persons per square km., compared to other Indian states. In terms of area, it is a little larger than Kerala, which is the 21st largest state in India, making it the 18th largest state. However, in terms of population, Himachal Pradesh is the 21st most populous state in India with a total population of approximately 68.6 lakhs (Census, 2011). The north state of Himachal Pradesh is further divided into 12 districts, each having their own geographical and demographic prevalence. Kangra, the largest district in the state, covers 5,739 square km. and is home to around 1.9 million people, having literacy rate 85.67 %.

Figure 3.1 Placement of Himachal Pradesh in India

Source: NIC, Delhi

Figure 3.2 Outline map of Himachal Pradesh

Source: https://himachal.nic.in

3.3 Population of the Study

The population for the study includes all senior secondary students of Class 12 from various government and private schools in District Kangra, Himachal Pradesh, who are enrolled in the Science stream with Physics as one of their major subjects. According to Statistical Data U-DISE (Collected as on 30th September, 2021) Himachal Pradesh, Science Stream enrolment of 12th Class in 2021-2022 in district Kangra is 7833 (Boys 4176 and Girls 3657).

3.4 Sample and Sampling Technique

According to Gay and Mills (2019), a good sample in quantitative research is one that fairly represents the population from which it was taken. The total number of schools offering the Science stream at the senior secondary level in the Kangra district of Himachal Pradesh state could be identified, but the precise number of senior secondary school students enrolled in physics in Class XII could not be predicted due to the lack of such records in the session 2023-24. The sample consists of 560 senior high school students one of the major subject physics and enrolled in the Science stream.

Sampling technique: Multistage

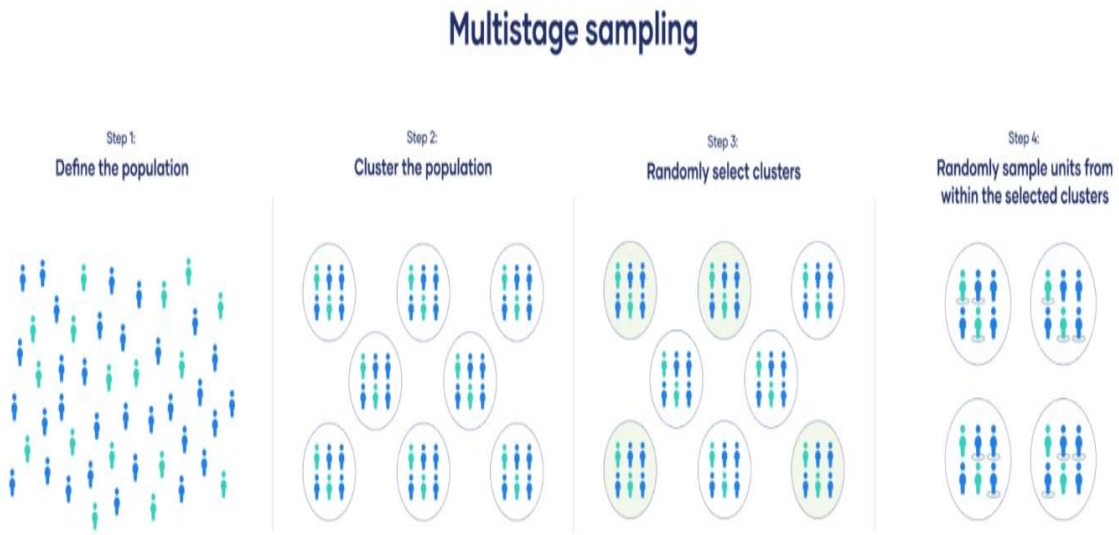

Figure 3.3 Diagrammatic representation of Multistage Sampling

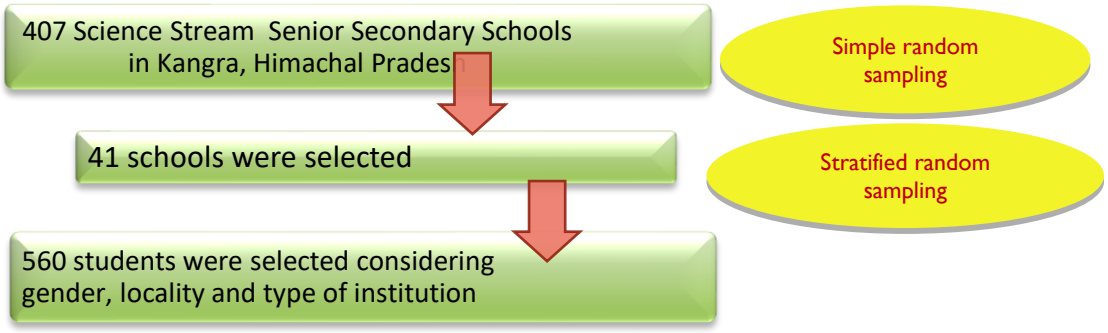

Figure 3.4 Diagrammatic representation of determination of sample size

Firstly, out of the 407 science stream senior secondary schools in District Kangra of Himachal Pradesh, 41 schools were selected by simple random sampling technique.

Secondly, considering gender, locality and type of institution 560 students from 41 schools were selected by stratified random sampling technique.

Table 3.1 Locality wise School Distribution of the final sample for the study

URBAN AREA SCHOOLS	RURAL AREA SCHOOLS
1. Dayanand Model Sr. Sec. School, Dharamshala 2. GSSS (Girls), Nurpur 3. GSSS (Boys), Nurpur 4. GSSS, Jawali 5. GSSS (Girls), Dharamshala 6. Gurukul Sr. Sec. School, Dharamshala 7. GSSS (Boys), Dharamshala 8. GAV Sr. Sec. School, Kangra 9. GSSS, Palampur 10. GSSS, Dari 11. Modern Public Sr. Sec. School, Kangra 12. St. Paul's Sr. Sec. School, Palampur 13. GSSS, New Kangra 14. GSSS, Dehra 15. Adarsh Bal Niketan Sr. Sec. School, Dehra 16. Govt Sr Sec School, Jawalamukhi 17. Govt. S. M. Sr. Sec. School, Indora	1. GSSS, Narwana 2. GSSS, Ganoh 3. GSSS, Jassur 4. GSSS, Raja Ka Talab 5. GSSS, Sidhbari 6. GSSS, Khaniara Khas 7. GSSS, Ghaniara 8. GSSS, Guglara 9. GSSS, Rehan 10. GSSS, Fatehpur 11. Greatway Public Sr. Sec. School, Sujjal 12. Tagore Sr. Sec. School, Rehan 13. Hans Raj Sr. Sec. School, Rehan 14. Dauladhar Public School, Yol Cantt. 15. New Era School of Sciences, Chattri 16. DAV Public Sr. Sec. School, Chalwara 17. Shivalik Sr. Sec. School, Panjhara 18. GSSS, Serathana 19. GSSS, Bagga Kuter 20. DAV Public School, Bankhandi 21. Dehra Public Sr. Sec. School, Khabli 22. Rosemary Public Sr. Sec. School, Haripur 23. GSSS, Haripur 24. Adarsh .Sr. Sec. School, Pragpur
Total= 244	**Total = 316**

Table 3.2 Type of Institution wise School Distribution of the final sample for the study

PRIVATE SCHOOLS	GOVERNMENT SCHOOLS
1. Dayanand Model Sr. Sec. School, Dharamshala 2. Greatway Public School, Sujjal 3. Tagore Sr. Sec. School, Rehan 4. Hans Raj Sr. Sec. School, Rehan 5. Dauladhar Public School, Yol Cantt. 6. New Era School of Sciences, Chattri 7. DAV Public Sr. Sec. School, Chalwara 8. Gurukul Sr. Sec. School, Dharamshala 9. GAV Sr. Sec. School, Kangra 10. Shivalik Sr. Sec. School, Panjhara 11. Modern Public Sr. Sec. School, Kangra 12. St. Paul's Sr. Sec. School, Palampur 13. Adarsh Bal Niketan Sr. Sec. School, Dehra 14. DAV Public School, Bankhandi 15. Dehra Public Sr. Sec. School, Khabli 16. Rosemary Public Sr. Sec. School, Haripur 17. Adarsh .Sr. Sec. School, Pragpur	1. GSSS, Narwana 2. GSSS, Ganoh 3. GSSS, Jassur 4. GSSS, (Girls), Nurpur 5. GSSS, (Boys), Nurpur 6. GSSS, Raja Ka Talab 7. GSSS, Jawali 8. GSSS (G), Dharamshala 9. GSSS (B), Dharamshala 10. GSSS, Sidhbari 11. GSSS, Khaniara Khas 12. GSSS, Ghaniara 13. GSSS, Guglara 14. GSSS, Rehan 15. GSSS, Palampur 16. GSSS, Fatehpur 17. GSSS, Dari 18. GSSS, Serathana 19. GSSS, Bagga Kuter 20. GSSS, New Kangra 21. GSSS, Dehra 22. GSSS, Haripur 23. GSSS, Jawalamukhi 24. Govt. S. M. Sen. Sec. School, Indora
Total= 239	**Total= 321**

Table 3.3 School Wise Distribution of the final sample for the study

Sr. No.	Name of School	No. of Students (Boys)	No. of Students (Girls)	Total No. of Students
1	Dayanand Model Sr. Sec. School, Dharamshala	**06**	**09**	**15**
2	GSSS (Girls), Nurpur	**00**	**12**	**12**
3	GSSS, Nurpur	**05**	**09**	**14**
4	GSSS, Jawali	**05**	**09**	**14**
5	GSSS (Girls), Dharamshala	**00**	**13**	**13**
6	Gurukul Sr. Sec. School, Dharamshala	**06**	**09**	**15**

7	GSSS, Dharamshala	**10**	**04**	**14**
8	GAV Sr. Sec. School, Kangra	**06**	**09**	**15**
9	GSSS, Palampur	**05**	**09**	**14**
10	GSSS, Dari	**05**	**09**	**14**
11	Modern Public Sr. Sec. School, Kangra	**06**	**09**	**15**
12	St. Paul's Sr. Sec. School, Palampur	**06**	**09**	**15**
13	GSSS, New Kangra	**05**	**09**	**14**
14	GSSS, Dehra	**06**	**09**	**15**
15	Adarsh Bal Niketan Sr. Sec. School, Dehra	**06**	**09**	**15**
16	GSSS, Jawalamukhi	**06**	**09**	**15**
17	Govt. S. M. Sr. Sec. School, Indora	**05**	**09**	**15**
18	GSSS, Narwana	**05**	**08**	**13**
19	GSSS, Ganoh	**05**	**08**	**13**
20	GSSS, Jassur	**05**	**09**	**14**
21	GSSS, Raja Ka Talab	**06**	**09**	**14**
22	GSSS, Sidhbari	**05**	**07**	**12**
23	GSSS, Khaniara Khas	**05**	**05**	**10**
24	GSSS, Ghaniara	**05**	**05**	**10**
25	GSSS, Guglara	**05**	**09**	**14**
26	GSSS, Rehan	**05**	**09**	**14**
27	GSSS, Fatehpur	**05**	**09**	**14**
28	Greatway Public Sr. Sec. School, Sujjal	**05**	**09**	**14**
29	Tagore Sr. Sec. School, Rehan	**05**	**09**	**14**
30	Hans Raj Sr. Sec. School, Rehan	**05**	**08**	**13**
31	Dauladhar Public School, Yol Cantt.	**05**	**09**	**14**
32	New Era School of Sciences, Chattri	**05**	**09**	**14**
33	DAV Public Sr. Sec. School, Chalwara	**05**	**09**	**14**
34	Shivalik Sr. Sec. School, Panjhara	**05**	**08**	**13**
35	GSSS, Serathana	**05**	**08**	**13**
36	GSSS, Bagga Kuter	**05**	**08**	**13**

37	DAV Public School, Bankhandi	**05**	**08**	**13**
38	Dehra Public Sr. Sec. School, Khabli	**05**	**08**	**13**
39	Rosemary Public Sr. Sec. School, Haripur	**05**	**08**	**13**
40	GSSS, Haripur	**05**	**08**	**13**
41	Adarsh .Sr. Sec. School, Pragpur	**05**	**09**	**14**
Total		**209**	**351**	**560**

Table 3.4 Distribution of Sample with Respect to gender, Type of Institution and Locality

		Gender	Total No. of students		Grand Total
Type of Institution	Private	Boys	91	239	**560**
		Girls	148		
	Government	Boys	118	321	
		Girls	203		
Locality	Urban	Boys	88	244	**560**
		Girls	155		
	Rural	Boys	121	316	
		Girls	196		

3.5 Variables used for the Study

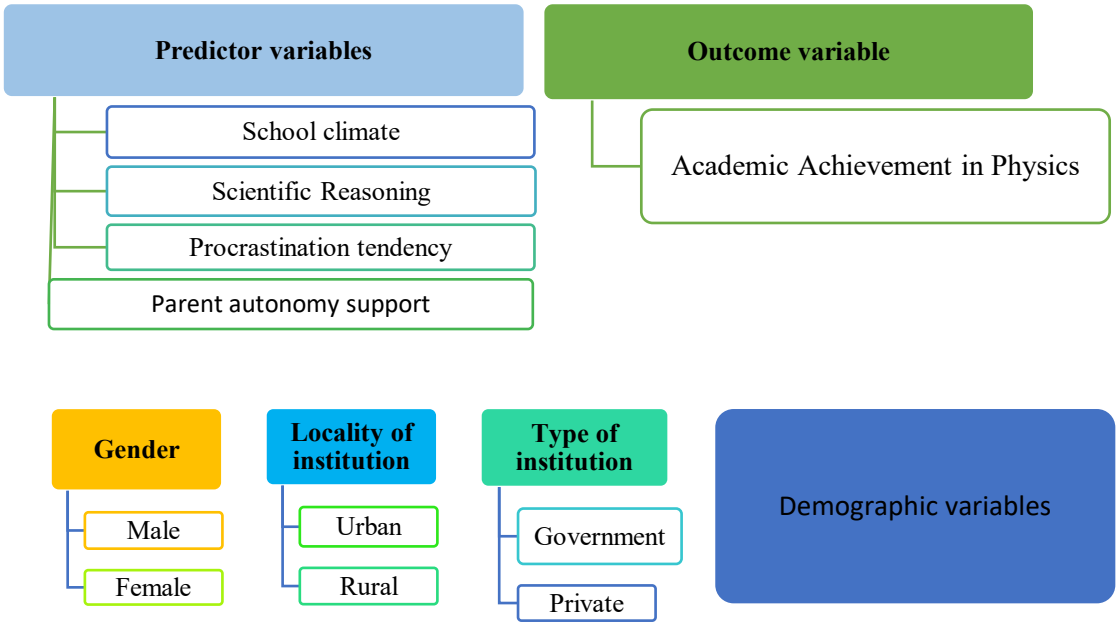

Figure 3.5 Diagrammatic representation of Variables

3.6 Tools used for the Study

Table 3.5 Tools used for the study

School Climate	Self-developed questionnaire
Scientific Reasoning	Lawson's classroom test of scientific reasoning (LTCSR) adapted from Lawson, A. E. (2000)
Procrastination Tendency	Procrastination Scale adapted from Lay (1986).
Parent Autonomy Support	Perceived Parental Autonomy Support Scale (P-PASS) adapted from Mageau et al (2015).
Achievement test in Physics	Self- developed achievement test

3.6.1 Description of Perceived School Climate Scale (PSCS)

The Perceived School Climate Scale (PSCS) was developed by the researcher following the definition of the concept as given by Sandy, S.V., Cohen, J. & Fisher, M.B. (2007), Higgins-D'Alessandro, A., Faster, D. & Cohen, J. (2010), Guo, P., Choe, J., & Higgins-D'Alessandro, A. (2011), Aud, S., Wilkinson-Flicker, S., Kristapovich, P., Rathbun, A., Wang, X., and Zhang, J. (2013), and Cimorelli, D. M. (2017), who conceptualised the school climate in terms of a continuum ranging from measured as a combination of rules and norms, a sense of physical and socio-emotional security, support for learning, interpersonal relationships, and school connectedness.

The Perceived School Climate Scale (PSCS) was developed by the researcher to assess senior secondary school students specifically for this study. The responses are collected on a 5-point Likert scale (Strongly disagree, Disagree, Undecided, Agree, and Strongly agree). The following steps are involved in preparing the preliminary draft of the scale to its final draft, right up to the establishment of its validity and reliability:

Preparation of the first draft of the scale

After identifying the dimensions of the scale on the basis of relevant literature reviewed, five dimensions were recognised: rules and norms, a sense of physical and socio-emotional security, support for learning, interpersonal relationships, and school connectedness. The investigator prepared the preliminary draft of the Perceived

School Climate Scale (PSCS) for senior secondary school students, comprising 59 items.

Scoring

As for the Perceived school climate scale (PSCS), the researcher used the 5-point Likert Scale. The scoring of the items was done in the following manner:

Table 3.6: 5-point Likert scale

Statements	**Strongly Disagree (SD)**	**Disagree (D)**	**Undecided (U)**	**Agree (A)**	**Strongly Agree (SA)**
Positive	1	2	3	4	5
Negative	5	4	3	2	1

Table 3.7 Dimension wise distribution of items of Perceived school climate scale (PSCS)

Sr. NO.	Dimensions	Items	Serial wise items No.	Total	
1	**Rules and Norms**	Positive	1, 13, 22, 27, 32, 37, 52	07	10
		Negative	10, 16, 25	03	
2	**Sense of physical and socio emotional Security**	Positive	2, 14, 17, 20, 39	05	10
		Negative	7, 11, 29, 35, 58	05	
3	**Support for Learning**	Positive	4, 8, 21, 24, 26, 31, 43, 57	08	11
		Negative	30, 41, 51	03	
4	**Interpersonal relationship**	Positive	6, 9, 12, 15, 18, 34, 40, 44, 48, 54, 56	11	18
		Negative	3, 23, 28, 38, 42, 46, 49	07	
5	**School connectedness**	Positive	4, 33, 36, 47, 53, 55	06	10
		Negative	19, 45, 50, 59	04	
	Total			59	

Face validity and Content validity of the scale

Gay & Mills (2019) describe face validity as "the degree to which a test appears to measure what it claims to measure." According to Anastasia (1958), "face validity refers not to what the test measures, but to what it seems, or appears, to measure." Content validity establishes how well a test measures a specific content area (Gay & Mills, 2019).

The scale was given to subject experts to establish its face validity and content validity by:

• Review the items for language and content scrutiny;

• Clarify any ambiguities;

• Make sure that the products are true to the size they have been created for;

• Based on the expert feedback, apply the necessary adjustments.

Preparation of the final draft of the scale

After receiving the feedback and evaluation reports from experts, sixteen items were modified; none were deleted.

The norms of reference were also developed for the interpretation of the test scores as follows:

The lowest score for the given tool is 59, and the highest is 295. Hence, the raw scores from 59 to 295 were first converted to z-scores.

Table 3.8 Norms for Interpretation of level of Z-Scores for the School Climate

Sr. No.	Range of Raw Score	Range of Z-Score	Level of School Climate
1	270 & above	+2.01 & above	Extremely High
2	249 to 269	+1.26 to +2.00	High
3	229 to 248	+0.51 to +1.25	Above Average
4	203 to 228	-0.50 to + 0.50	Average
5	184 to 202	-1.25 to -0.51	Below Average
6	162 to 183	-2.00 to -1.26	Low
7	161 & below	-2.01 & below	Extremely Low

First pilot testing

The pilot testing was carried out in two phases:

In the first phase, the scale was pilot tested on 30 students to determine whether the items are meaningful to the target group and legible by them, whether the sentence structures are understood, and whether any of the items need to be further simplified. The researcher additionally engaged with the students in order to gain a deeper understanding of the items' representativeness and the language used in the research. A few statements had to be simplified. In the second phase, the scale was administered to 120 students to establish the reliability of the scale.

Reliability of the Perceived School Climate Scale (PSCS)

Internal Consistency of the PSCS

The internal consistency of the final 59-item Perceived School Climate Scale (PSCS) was measured using Cronbach's alpha, a standard method for checking how well the items on a scale work together. The resulting alpha value was:

Cronbach's alpha = .864,

This value is above the commonly accepted benchmark of .80. This indicates strong internal consistency, meaning the items reliably measure the overall concept of perceived school climate. The strong reliability, along with effective item discrimination, confirms that this 59-item version of the PSCS is psychometrically sound and suitable for use in the main study.

Test-retest reliability: The degree of consistency in test scores over time is known as test-retest reliability, or test of stability (Gay & Mills, 2019).

The Perceived School Climate Scale was administered on the same group of students (N=120) twice at an interval of 3 weeks between the test and the retest. The test-retest reliability coefficient was found to be 0.81, indicating high reliability.

3.6.2 Description of Lawson's Classroom Test of Scientific Reasoning (LTCSR) adapted from Lawson, A. E. (2000)

Lawson's Classroom Test of Scientific Reasoning (LTCSR), developed by Lawson, A. E. (2000), was employed to ascertain the level of scientific reasoning. The questionnaire has 24 items.

Table 3.9: Distribution of Scheme tested items of Lawson's Classroom Test of Scientific Reasoning (LTCSR)

Scheme tested	Question items of LCTSR	Task details
Conservation of weight	1, 2	Changing the forms of two identical balls of clay that are located on opposite sides of a balance.
Conservation of volume	3, 4	Exploring the displacement volumes of two densities of a cylinder.
Proportional reasoning	5, 6, 7, 8	Filling with water between those wide and narrow cylinders and guessing at their height
Control of variables	9, 10	Length of a pendulum — producing experiments
Control of variables	11, 12, 13, 14	Investigating the effects of red/blue light and gravity using flies in tubes.
Probability	15, 16, 17, 18	Making predictions about the probabilities of drawing specific Colour wooden blocks from a bag.
Correlation reasoning	19, 20	Having presented data, predict whether there is a correlation between the size of the mice and the colour of their tails.
Hypothetical-deductive reasoning	21, 22	Planning experiments to find out what made the water rush into the glass after the lit candle went out.
Hypothetical-deductive reasoning	23, 24	Structuring experiments to explain why red blood cells shrink when added to a few drops of salt water.

The statements are scored either as 1 or 0. A total score for scientific reasoning is obtained by adding the scores of all 24 items. For each scheme tested, the scores are totalled.

Justification behind selecting Lawson's Classroom Test of Scientific Reasoning (LTCSR): The rationale behind utilising the Lawson's Classroom Test of Scientific Reasoning developed by Lawson, A. E. (2000) within this research context derives from a thorough examination of pertinent literature, scales, and tools. Following an exhaustive review of relevant resources, the researcher deliberately selected Lawson's

Classroom Test of Scientific Reasoning, aligning it with the precise objectives of the present study.

This outcome highlights the suitability and utility of the metric within the research framework. Thus, the choice of Lawson's Classroom Test of Scientific Reasoning represents a deliberate, evidence-based decision, based on its previous effectiveness and alignment with research goals, as well as its methodological robustness, relevancy to the population studied, level of cognition, and use of clear language in order to reach participants. The selection was several reasons to adapt. These are:

Broad Usage: Scale has been widely used in many research studies, highlighting its widespread acceptance and applicability.

Ease of Administration and Scoring: The total mean score can be easily calculated, making it a practical tool for research use.

Relevance and Fit with Study Goals: The content and items of the scale align closely with the goals of the current study, facilitating the measurement of teacher effectiveness in the context being studied.

Reliability and Validity: The scale has been demonstrated to be reliable and valid in prior evidence.

Applicability of the Scale to Senior Secondary School Students: The scale was deemed appropriate for Senior Secondary School Students, establishing lens size relevance and accuracy in the scientific reasoning assessment associated with...

Use of clear and understandable language: The use of the language of the scale is very simple, and one can easily understand what is being asked and can respond to the questions without any confusion.

Norms for Interpretation of Level of Z-Scores for the Lawson's Classroom Test of Scientific Reasoning (LTCSR):

Norms of reference were developed by the investigator for the interpretation of the test scores as follows: The lowest score for the given tool is 0, and the highest is 24. Hence, the raw scores from 0 to 24 were first converted to z-scores. Next, the z-scores were fitted in the normal probability curve in order to ascertain the extremely high,

high, above average, average, below average, low, and extremely low levels for scientific reasoning.

Table 3.10 Norms for Interpretation of level of Z-Scores for the Scientific Reasoning

Sr. No.	Range of Raw Score	Range of Z-Score	Level of Scientific reasoning
1	12 & above	+2.01 & above	Extremely High
2	10 & 11	+1.26 to +2.00	High
3	Only 9	+0.51 to +1.25	Above Average
4	6 to 8	-0.50 to + 0.50	Average
5	Only 5	-1.25 to -0.51	Below Average
6	Only 4	-2.00 to -1.26	Low
7	3 and below	-2.01 & below	Extremely Low

Reliability of Lawson's Classroom Test of Scientific Reasoning (LTCSR):

Test-Retest Reliability: The Lawson's Classroom Test of Scientific Reasoning (LTCSR) was administered on the same group of students (N=120) twice at an interval of 3 weeks. The test-retest reliability coefficient obtained was found to be 0.83, which indicates high reliability.

3.6.3 Description of Procrastination Scale adapted from Lay (1986)

The Procrastination Scale developed by Lay (1986) was employed to ascertain the level of procrastination tendency. The questionnaire has 20 items in 5 dimensions.

Table 3.11 Dimension wise distribution of items of Procrastination Scale

Dimension/Factor of Procrastination Scale	Items
Factor 1. Good planning	8, 14, 15, 18, and 20.
Factor 2. Delaying	5,9,11,12 and 19.
Factor 3. Doing things in last minute	16 and 17.
Factor4. Good time management	3,4,6 and 13.
Factor 5: Poor time management	1,2,7 and 10.

Scoring key: Extremely Moderately 1 Neutral Moderately 2 Extremely Uncharacteristic 3 Uncharacteristic Characteristic 4 Characteristic 5

Reversed-keyed items: 3,4,6,8,11,13,14,15,18,20

Justification behind selecting the Procrastination Scale of Lay (1986): The Procrastination Scale, developed by Lay (1986), was chosen for psychometric reliability and validity to measure procrastination as a behavioural trait. Lay's framework is well known and has been developed for a variety of academic and general contexts, both for examining delay tendencies. It is appropriate for estimating procrastination among adolescent senior secondary students due to its adaptability and ease of administration. In addition, this scale's already-established relevance to academic procrastination would connect properly with the focus of the study, to discover how procrastination within students can have an impact on their outcome in physics, a subject that is clearer when you are actively engaged in it frequently. Implementing this scale can anchor these findings within a proven theoretical and empirical framework, providing accurate insights into student procrastination in the context of Himachal Pradesh.

Norms for Interpretation of Level of Z-Scores for the Procrastination Scale:

Norms of reference were developed by the investigator for the interpretation of the test scores as follows: The lowest score for the given tool is 20, and the highest is 100. Hence, the raw scores from 20 to 100 were first converted to z-scores. Next, the z-scores were fitted in the normal probability curve in order to ascertain the extremely high, high, above average, average, below average, low, and extremely low levels for procrastination tendency.

Table 3.12 Norms for interpretation of Z-Score for the level of the Procrastination Tendency

Sr. No.	Range of Raw Score	Range of Z-Score	Level of Procrastination Tendency
1	79 & above	+2.01 & above	Extremely High
2	73 to 78	+1.26 to +2.00	High
3	68 to 72	+0.51 to +1.25	Above Average
4	61 to 67	-0.50 to + 0.50	Average
5	55 to 60	-1.25 to -0.51	Below Average
6	50 to 54	-2.00 to -1.26	Low
7	49 & below	-2.01 & below	Extremely Low

Reliability of Procrastination Scale of Lay (1986)

Test-Retest Reliability: The Procrastination Scale was administered on the same group of students (N=120) twice at an interval of 3 weeks. The test-retest reliability coefficient obtained was found to be 0.84, which indicates high reliability.

3.6.4 Description of Perceived Parental Autonomy Support Scale (P-PASS) adapted from Mageau et al. (2015)

To measure the level of parental autonomy support, the Perceived Parental Autonomy Support Scale (P-PASS) by Mageau et al. (2015) was used. The questionnaire has 24 items in 2 dimensions—autonomy support and psychological control—comprising 3 subdimensions each, respectively. The 3 subdimensions for autonomy support include choice within certain limits (4 items), explaining the reasons behind the demands, rules, and limits (4 items), and being aware of, accepting, and recognising the child's feelings (4 items), while the 3 subdimensions for psychological control include threatening to punish the child (4 items), inducing guilt (4 items), and encouraging performance goals (4 items). Because autonomy support and psychological control are two poles of the same continuum, namely that of children's perception of autonomy, one should be able to simply code the psychological control items in the reverse direction to generate a single composite representing autonomy support. Some researchers disagree, however, arguing that since they are two factors, they should not be combined. Hence the trend to look at them one by one.

Table 3.13 Dimensions of Perceived Parental Autonomy Support Scale (P-PASS)

Dimension of P-PASS	Subdimension	Items
Autonomy-support	Choice within certain limits	1, 4, 8, 14
	Explaining the reasons behind the demands, rules, and limits	2, 9, 19, 23
	Being aware of, accepting, and recognizing the child's feelings	7, 13, 16, 24
Psychological Control	Threatening to punish the child	3, 10, 15, 20
	Inducing guilt	6, 12, 18, 21
	Encouraging performance goals	5, 11, 17, 22

Scoring Key: Do not agree at all 1, hardly agree 2, slightly agree 3, somewhat agree 4, agree 5, strongly agree 6, very strongly agree 7.

Justification behind selecting the Perceived Parental Autonomy Support Scale (P-PASS) adapted from Mageau et al. (2015):

The Perceived Parental Autonomy Support Scale (P-PASS) (adapted from Mageau et al. (2015)) is the most appropriate tool for the research: Parental Autonomy Support of Senior Secondary School Students and Its Relationship with Their Academic Achievement in Physics in Himachal Pradesh. The scale gauges how the parents create a situation in which independent decision-making is encouraged and the child's sense of self-direction is affirmatively supported. It includes items that reflect important facets of autonomy support, such as using rationale for rules, validating children's feelings, and providing choice.

Currently, the version of the tool includes separate subscales for mothers and fathers to investigate potential differences in perceived autonomy support. These are of a type in which people agree or disagree based on the Likert-type approach usually used in bigger surveys used in these paper formats, for example, when asked to rate the behaviours of their parents.

Results of the Pilot Study:

Fathers and Mothers Have Similar Scores: A pilot study among senior secondary school students in Himachal Pradesh showed no notable distinctions between the scores mothers and fathers scored on the P-PASS. This indicates that students generalise that both parents afford a similar level of autonomy support in daily life.

Cultural Relevance: Typically, in Indian culture, especially in rural and semi-urban environments, such as Himachal Pradesh, there is little difference in the responsibilities of mothers and fathers, as their roles in the family often overlap, and both parents are equally involved in all discussions related to their children's education and upbringing. This reduces the need for mothers' and fathers' roles to be made as separate as they are in Western contexts.

Practical Consideration: Averaging a score of an adapted version of the tool would have made it easier for its application at the services and generated valid and deep findings. This method has significant implications for large-scale studies, where rapid data analysis is critical.

Rationale for Using the Average Score:

Enhanced Reliability: If mother's and father's scores are not very far apart, averaging provides increased reliability. This adjustment is more reflective of common parental influence.

Context-Specific Relevance: The adaptation to overall perceived autonomy support as opposed to separating based on parental gender makes the tool more contextual and closely aligned with the cultural and social norms of senior secondary school students in Himachal Pradesh.

Focus on Research Objective: The goal is to investigate the relationship between perceived parental autonomy support and academic behaviours such as scientific reasoning or procrastination. Total score is a comprehensive reflection of parental input, which simplifies the analysis.

Justifying the adaptation of the P-PASS for the Indian cultural setting by averaging scores for both parents has ensured that the psychometric implications of the tool are not lost while keeping the socio-cultural specificities intact.

Z-score norms for the Perceived Parental Autonomy Support Scale (P-PASS)

Table 3.14 Norms for interpretation of Z-Score for the level of the Autonomy Support (Dimension 1 of Parental Autonomy Support)

Sr. No.	Range of Raw Score	Range of Z-Score	Level of Autonomy Support
1	82 & above	+2.01 & above	Extremely High
2	72 to 81	+1.26 to +2.00	High
3	63 to 71	+0.51 to +1.25	Above Average
4	50 to 62	-0.50 to + 0.50	Average
5	40 to 49	-1.25 to -0.51	Below Average
6	31 to 39	-2.00 to -1.26	Low
7	30 & below	-2.01 & below	Extremely Low

Table 3.15 Norms for interpretation of Z-Score for the level of the Psychological Control (Dimension 2 of Parental Autonomy Support)

Sr. No.	Range of Raw Score	Range of Z-Score	Level of Psychological Control
1	63 & above	+2.01 & above	Extremely High
2	54 to 62	+1.26 to +2.00	High
3	46 to 53	+0.51 to +1.25	Above Average
4	34 to 45	-0.50 to + 0.50	Average
5	25 to 33	-1.25 to -0.51	Below Average
6	16 to 24	-2.00 to -1.26	Low
7	15 & below	-2.01 & below	Extremely Low

Reliability of the Perceived Parental Autonomy Support Scale (P-PASS):

Test-Retest Reliability: The Perceived Parental Autonomy Support Scale (P-PASS) was given to the same set of students (N=120) who were tested twice with a 3-week gap between the test and the retest. The test-retest reliability coefficient obtained was found to be 0.78, which indicates high reliability.

3.6.5 Achievement test in Physics

Blueprint of the Achievement Test: Before the items could be developed for the achievement test, a blueprint was developed, against which questions for the test were built.

Achievement Test Blueprint

Table 3.16 Weightage to Objectives

Domain	**Marks**	**Marks%**	**1 mark**	**2 marks**
Remembering	20	22 %	20	0
Understanding	26	28 %	20	6
Application	16	18 %	12	4
Analyse	16	18 %	10	6
Evaluate	6	7 %	4	2
Create	6	7 %	4	2
Total	90	100 %	70	20

Table 3.17 Weightage to Types of questions

Type of question	No. of items	Marks per question	Total Marks	Marks%
Objective type	70	1	70	78%
Short answer type	10	2	20	22%
Total	80		90	100%

Table 3.18 Distribution of items according to the Chapter and Cognitive Domains

Chapter No. & Name	Remember		Understand		Apply		Analyse		Evaluate		Create		Total
	O	S	O	S	O	S	O	S	O	S	O	S	
Chapter 1 Electric Charges and Fields	1 (1)			1 (2)	2 (2)		1 (1)				1 (1)		6 (7)
Chapter 2 Electrostatic Potential and Capacitance	1 (1)				1 (1)	1 (2)	1 (1)				1 (1)		5 (6)
Chapter 3 Current Electricity	1 (1)		2 (2)		1 (1)			1 (2)	1 (1)				6 (7)
Chapter 4 Moving Charges and Magnetism	1 (1)		2 (2)		1 (1)		1 (1)		1 (1)				6 (6)
Chapter 5 Magnetism and Matter	1 (1)		1 (1)	1 (2)	1 (1)		2 (2)				1 (1)		7 (8)
Chapter 6 Electromagnetic Induction	1 (1)		1 (1)			1 (2)	1 (1)				1 (1)		5 (6)
Chapter 7 Alternating Current	1 (1)		2 (2)				2 (2)						5 (5)
Chapter 8 Electromagnetic Waves	1 (1)		1 (1)		1 (1)			1 (2)					4 (5)
Chapter 9 Ray Optics and Optical Instruments	1 (1)		1 (1)		2 (2)								4 (4)
Chapter 10 Wave Optics	1 (1)		2 (2)						1 (1)				4 (4)
Chapter 11 Dual Nature of Radiation and Matter	1 (1)		1 (1)	1 (2)	1 (1)				1 (1)				5 (6)
Chapter 12 Atoms	1 (1)		2 (2)				1 (1)						4 (4)
Chapter 13 Nuclei	2 (2)		3 (3)							1 (2)			6 (7)
Chapter 14 Semiconductor Electronics: Materials, Devices	2 (2)		1 (1)		2 (2)		1 (1)					1 (2)	7 (8)

and Simple Circuits													
Chapter 15 Communication Systems	4 (4)		1 (1)					1 (2)					6 (7)
Total	20 (20)		20 (20)	3 (6)	12 (12)	2 (4)	10 (10)	3 (6)	4 (4)	1 (2)	4 (4)	1 (2)	80 (90)

Development of preliminary draft

The first draft of the achievement test consisted of 70 objective-type questions and 10 short answer questions. The first draft in case any deletions and replacements were required to be made based on the suggestions from experts.

Face validity and content validity of the test

Gay & Mills (2019) state that content validity is particularly important in the case of achievement tests. If a test does not assess what a student was taught and should have learnt, it cannot accurately reflect a student's achievement. Content validity will be threatened if the test includes material that has not been taught or does not cover material that has been taught.

Once the 1st draft of the test was ready, it was shared with physics subject experts to:

• Critically examine the items for language and content;

• Clarify any ambiguities;

• Ensure that the devices properly represent the measurements for which they were designed;

• Get the necessary alterations done as per the comments given by the specialists.

First pilot testing

After receiving the necessary feedback and suggestions from subject experts, 70 objective-type and 10 short-answer-type questions were retained. The preliminary draft was then pilot tested on 120 students for further standardisation of the test.

Discrimination index and difficulty value of the items

An item analysis of the test was conducted to find out if the items are suitable for the test. It included calculating their discrimination values and difficulty indices. For this, the scores obtained by the students in the achievement test were taken.

Table 3.19 Scores obtained in Pilot Study for Achievement Test in Physics

Student	Marks obtained	Student	Marks obtained	Student	Marks obtained
S1	32	S41	32	S81	39
S2	37	S42	39	S82	25
S3	38	S43	35	S83	30
S4	30	S44	40	S84	30
S5	38	S45	45	S85	36
S6	37	S46	32	S86	44
S7	44	S47	37	S87	32
S8	40	S48	30	S88	44
S9	35	S49	34	S89	47
S10	35	S50	35	S90	47
S11	36	S51	42	S91	45
S12	40	S52	40	S92	42
S13	34	S53	35	S93	44
S14	33	S54	30	S94	44
S15	31	S55	30	S95	34
S16	35	S56	27	S96	26
S17	32	S57	42	S97	45
S18	37	S58	25	S98	36
S19	33	S59	38	S99	35
S20	40	S60	27	S100	41
S21	35	S61	35	S101	42
S22	40	S62	31	S102	41
S23	34	S63	25	S103	37
S24	43	S64	30	S104	38
S25	32	S65	35	S105	43
S26	33	S66	29	S106	28
S27	33	S67	43	S107	27
S28	30	S68	35	S108	41
S29	31	S69	31	S109	41
S30	30	S70	38	S110	30
S31	35	S71	34	S111	28
S32	40	S72	26	S112	38
S33	32	S73	32	S113	40
S34	36	S74	44	S114	27
S35	47	S75	39	S115	36
S36	29	S76	27	S116	32
S37	42	S77	36	S117	36
S38	37	S78	29	S118	29
S39	32	S79	42	S119	36
S40	37	S80	35	S120	39

After this, the scores of the top 27% (32 students) and bottom 27% (32 students) of the total test takers were calculated.

Table 3.20 Difficulty values (DV) and Discrimination Indices (DI) of the items

Item	DV	Interpretation	Result	Action taken	DI	Interpretation	Result	Action taken
Q1	0.57	Moderate	Keep		0.58	Very good item	Keep	
Q2	0.58	Moderate	Keep		0.70	Very good item	Keep	
Q3	0.72	Easy	Keep/ Revise		0.56	Very good item	Keep	
Q4	0.81	Very easy	Discard/ Revise	Revised	0.29	Mediocre item	Discard/ Revise	Revised
Q5	0.75	Easy	Keep/ Revise		0.37	Good item	Keep/ Revise	
Q6	0.73	Easy	Keep/ Revise		0.36	Good item	Keep/ Revise	
Q7	0.57	Moderate	Keep		0.58	Very good item	Keep	
Q8	0.59	Moderate	Keep		0.28	Mediocre item	Discard/ Revise	Revised
Q9	0.61	Moderate	Keep		0.58	Very good item	Keep	
Q10	0.57	Moderate	Keep		0.32	Good item	Keep/ Revise	
Q11	0.56	Moderate	Keep		0.37	Good	Keep/ Revise	
Q12	0.47	Moderate	Keep		0.43	Very good item	Keep	
Q13	0.59	Moderate	Keep		0.48	Very good item	Keep	
Q14	0.45	Moderate	Keep		0.58	Very good item	Keep	
Q15	0.59	Moderate	Keep		0.67	Very good item	Keep	
Q16	0.51	Moderate	Keep		0.39	Good item	Keep/ Revise	
Q17	0.89	Very easy	Discard/ Revise	Revised	0.27	Mediocre item	Discard/ Revise	Revised
Q18	0.55	Moderate	Keep		0.55	Very good item	Keep	
Q19	0.88	Very easy	Discard/ Revise	Revised	0.26	Mediocre item	Discard/ Revise	Revised
Q20	0.78	Easy	Keep/Revise		0.39	Good item	Keep/ Revise	
Q21	0.47	Moderate	Keep		0.49	Very good item	Keep	
Q22	0.58	Moderate	Keep		0.82	Very good item	Keep	
Q23	0.57	Moderate	Keep		0.39	Good item	Keep/ Revise	
Q24	0.59	Moderate	Keep		0.73	Very good item	Keep	
Q25	0.57	Moderate	Keep		0.77	Very good item	Keep	
Q26	0.58	Moderate	Keep		0.70	Very good item	Keep	
Q27	0.59	Moderate	Keep		0.38	Good	Keep/ Revise	
Q28	0.43	Moderate	Keep		0.43	Very good item	Keep	
Q29	0.59	Moderate	Keep		0.47	Very good item	Keep	
Q30	0.57	Moderate	Keep		0.55	Very good item	Keep	
Q31	0.47	Moderate	Keep		0.46	Very good item	Keep	
Q32	0.55	Moderate	Keep		0.54	Very good item	Keep	
Q33	0.19	Very difficult	Discard/ Revise	Revised	0.28	Mediocre item	Discard/ Revise	Revised
Q34	0.18	Very difficult	Discard/ Revise	Revised	0.29	Mediocre item	Discard/ Revise	Revised
Q35	0.57	Moderate	Keep		0.48	Very good item	Keep	
Q36	0.50	Moderate	Keep		0.58	Very good item	Keep	
Q37	0.19	Very difficult	Discard/ Revise	Revised	0.28	Mediocre item	Discard/ Revise	Revised
Q38	0.78	Easy	Keep/ Revise		0.37	Good item	Keep/ Revise	

Q39	0.74	Easy	Keep/ Revise		0.39	Good item	Keep/ Revise	
Q40	0.27	Difficult	Keep/ Revise		0.47	Very good item	Keep	
Q41	0.73	Easy	Keep/ Revise		0.36	Good item	Keep/ Revise	
Q42	0.55	Moderate	Keep		0.55	Very good item	Keep	
Q43	0.78	Easy	Keep/ Revise	Revised	0.48	Very good item	Keep	
Q44	0.43	Moderate	Keep		0.47	Very good item	Keep	
Q45	0.74	Easy	Keep/ Revise		0.39	Good item	Keep/ Revise	
Q46	0.68	Easy	Keep/ Revise		0.54	Very good item	Keep	
Q47	0.52	Moderate	Keep		0.49	Very good item	Keep	
Q48	0.57	Moderate	Keep		0.67	Very good item	Keep	
Q49	0.52	Moderate	Keep		0.53	Very good item	Keep	
Q50	0.49	Moderate	Keep		0.53	Very good item	Keep	
Q51	0.72	Easy	Keep/ Revise		0.56	Very good item	Keep	
Q52	0.77	Easy	Keep/ Revise		0.63	Very good item	Keep	
Q53	0.48	Moderate	Keep		0.61	Very good item	Keep	
Q54	0.35	Difficult	Keep/ Revise		0.37	Good item	Keep/ Revise	
Q55	0.80	Easy	Keep/ Revise		0.31	Good item	Keep/ Revise	
Q56	0.75	Easy	Keep/ Revise		0.38	Good item	Keep/ Revise	
Q57	0.58	Moderate	Keep		0.84	Very good item	Keep	
Q58	0.77	Easy	Keep/ Revise		0.35	Good item	Keep/ Revise	
Q59	0.58	Moderate	Keep		0.56	Very good item	Keep	
Q60	0.59	Moderate	Keep		0.28	Mediocre item	Discard/ Revise	Revised
Q61	0.18	Very difficult	Discard/ Revise	Revised	0.29	Mediocre item	Discard/ Revise	Revised
Q62	0.58	Moderate	Keep		0.52	Very good item	Keep	
Q63	0.85	Very easy	Discard/ Revise	Revised	0.27	Mediocre item	Discard/ Revise	Revised
Q64	0.77	Easy	Keep/ Revise		0.38	Good item	Keep/ Revise	
Q65	0.47	Moderate	Keep		0.78	Very good item	Keep	
Q66	0.54	Moderate	Keep		0.68	Very good item	Keep	
Q67	0.59	Moderate	Keep		0.39	Good item	Keep/ Revise	
Q68	0.62	Moderate	Keep		0.71	Very good item	Keep	
Q69	0.58	Moderate	Keep		0.72	Very good item	Keep	
Q70	0.54	Moderate	Keep		0.66	Very good item	Keep	
Q71	0.44	Moderate	Keep		0.46	Very good item	Keep	
Q72	0.54	Moderate	Keep		0.67	Very good item	Keep	
Q73	0.48	Moderate	Keep		0.41	Very good item	Keep	
Q74	0.43	Moderate	Keep		0.41	Very good item	Keep	
Q75	0.70	Easy	Keep/ Revise		0.50	Very good item	Keep	
Q76	0.73	Easy	Keep/ Revise		0.55	Very good item	Keep	
Q77	0.45	Moderate	Keep		0.55	Very good item	Keep	

Q78	0.32	Difficult	Keep/ Revise		0.39	Good item	Keep/ Revise	
Q79	0.33	Difficult	Keep/ Revise		0.38	Good item	Keep/ Revise	
Q80	0.58	Moderate	Keep		0.64	Very good item	Keep	

A few questions were updated for the final version of the test. The concluding draft of the test comprised 70 multiple-choice-type questions of 1 mark each and 10 short-answer-type questions of 2 marks each. So, the total marks of the test were 90.

The following norms of reference were developed by the investigator for the interpretation of the test scores after preparing the final draft of the test:

A sample of 120 students was taken to administer the test. Z-score norms and interpretation of the norms according to scores obtained by students are given in Table 3.

Table 3.21 Norms for interpretation of Z-Score for the level of the Academic Achievement in Physics

Sr. No.	Range of Raw Score	Range of Z-Score	Level of Academic Achievement in Physics
1	45 & above	+2.01 & above	Extremely High
2	42 to 44	+1.26 to +2.00	High
3	38 to 41	+0.51 to +1.25	Above Average
4	33 to 37	-0.50 to + 0.50	Average
5	29 to 32	-1.25 to -0.51	Below Average
6	25 to 28	-2.00 to -1.26	Low
7	24 & below	-2.01 & below	Extremely Low

The Reliability of the Achievement Test in Physics

Internal Consistency of the Achievement Test in Physics: To assess the overall internal consistency of the instrument, a standardised Cronbach's alpha was calculated. This method was chosen due to the variation in item response formats and scoring weights, which made the use of traditional alpha based on raw scores less appropriate. The resulting standardised Cronbach's alpha for the 80-item version was:

Cronbach's alpha (standardised) = 0.812

This value reflects a satisfactory level of internal consistency, indicating that the 80 items collectively offer a reliable measure of academic achievement in physics among senior secondary school students.

Test-Retest Reliability: We used the test-retest method to check the reliability of the final draft of the achievement test. The interval between test and retest was three weeks. The test has a reliability coefficient of 0.82, which indicates high reliability.

3.7 Procedure of Data Collection

Initially, the investigator collected data by taking the consent from Deputy Director of Higher Education Kangra–Dharamshala, Government of Himachal Pradesh. Researchers meet respective principals/heads of schools and intimate them too after getting an official approval from the competent authority. The researcher set the dates for administering the tools and collecting data. In an effort to improve participants' response validity, the investigator briefly communicated the aims and objectives of the study to the subjects before the questionnaires were distributed. The researcher consistently guided reassuringly stable and trusting relations to them, including the importance of their participation in the study. The investigator then administered the instruments directly to the students.

3.8 Descriptive Statistics and Interpretation

Research, an extensive category of statistical methods, uses tools and techniques for the organised collection, analysis, interpretation, presentation, and organisation of data. As a domain, statistics provides several methodological tools and analytical frameworks for analysing and understanding complex datasets and extracting insights from empirical results. These are essential tools that researchers use to make sense of data and derive conclusions from their research.

Responses collected were scored systematically, using appropriate scoring keys. The data relevant to the analysis were compiled from the collected survey sample. Data were analysed using the SPSS-27. Data were analyzed using statistical measures (mean, standard deviation, frequency, percentages, and bar graphs), skewness, kurtosis, normality test, independent samples t-test, Pearson correlation, and regression analysis.