CHAPTER – IV

Data Analysis and Interpretation

Analysis of data means studying the organized material in order to discover inherent fact. The analysis and interpretation of collected data for a particular study are important in order to draw conclusions. There is something more crucial in research than the facts and figures. The analysis and interpretation of data involve breaking down existing complex facts into simpler parts and putting the parts together in new arrangements for the purpose of interpretation.

According to Good, Bars and Scates (1914), the process of interpretation is essentially, one of the stating what the results show? What they mean? What is their significance? What is the answer of the original problem?" This is all the limitation of the data must enter into and become the part of interpretation of the result Thus, the analysis of data means studying the tabulated material in order to determine inherent factors or meanings. It involves breaking down the existing complex facts into simpler parts and putting the parts together in new arrangement for the purpose of interpretation.

Keeping in view the objectives of the study, the data was statistically processed using appropriate design and technique. Hence, the desired data has been collected by using the tools: questionnaire on awareness and perception of pupil teachers on fostering innovation, experiential learning, and future employability through ATL are developed and standardised by author. The qualitative analysis and corresponding interpretations of data pertaining to the present study are discussed under.

4.1 Demographic Background:

Table 4. 1 Percentage distribution of sample by gender and courses.

	Male (%)	**Female (%)**	**Total (%)**
ITEP	12	8	20
B. A B.Ed	7	9	16
B.Sc B.Ed	15	5	20

B.Ed	8	5	13
Int. B.Ed M.Ed	15	16	31
Total	57	43	100

The table presents the distribution of 100 pupil-teachers across five different teacher-education programs at RIE Bhopal, categorized by gender. Of the total sample, 57% are male and 43% are female, indicating a moderate gender imbalance favoring male respondents. This pattern is reflected to varying degrees across individual courses.

In ITEP out of 20 students, 12 are male (60%) and 8 are female (40%). The gender distribution here is slightly skewed toward males but still reflects relatively balanced representation. B. A B.Ed course includes 16 participants, with 7 males (43.75%) and 9 females (56.25%). This is the only course where females outnumber males, suggesting that the arts-based integrated course may be more attractive or accessible to female pupil-teachers. In B.Sc B.Ed among the 20 students in this science-based integrated course, 15 are male (75%) and only 5 are female (25%). This reveals a notable gender disparity, highlighting that science-oriented teacher-education tracks remain male-dominated within this context. The standalone B.Ed. program consists of 13 participants, including 8 males (61.5%) and 5 females (38.5%). Although the sample is small, the trend of higher male representation continues. Integrated B.Ed.–M.Ed. group is the largest, with 31 participants. It shows an almost even gender split, with 15 males (48.39%) and 16 females (51.61%). This nearly equal representation suggests balanced enrolment in this comprehensive integrated program.

Across the entire sample, male pupil-teachers outnumber females (57% vs. 43%), but the distribution varies by program. While the B.A. B.Ed. and Int. B.Ed.–M.Ed. courses exhibit more balanced or female-dominant gender ratios, the B.Sc. B.Ed. and B.Ed. programs are clearly male-majority. These findings could reflect broader societal trends in gendered course preferences such as stronger male participation in science education programs and may have implications for future efforts aimed at achieving gender balance across all streams of teacher education.

4.2 Results related to Awareness of pupil teachers on Atal Tinkering Labs:

Table 4. 2 Awareness of Pupil-Teachers on Atal Tinkering Lab.

S. No.	Items	Yes (%)	No (%)
1	Have you heard about Atal Tinkering Labs?	87	13
2	Do you know the eligibility criteria for schools to set up an ATL?	32	68
3	Have you ever visited an ATL-equipped school?	62	38
4	Are you aware of the financial support provided under ATL to schools?	38	62
5	ATLs primarily focus on science domain?	77	23
6	ATL aims to promote passive learning?	29	71
7	Are ATL activities integrated with regular school curriculum?	72	28
8	ATL promotes the concept of "Do-It-Yourself" (DIY) learning. Are you aware of this?	84	16
9	Have you participated in ATL activities in your school time?	29	71

10	Are you familiar with basic coding languages taught in ATL (e.g., Scratch, Python)?	41	59
11	Have you received any training in ATL technologies?	24	76
12	Are you aware of how 3D printers are used in ATL projects?	42	58
13	Is there any provision for college students under Atal Innovation mission?	48	52
14	ATL promotes design thinking among students. Are you aware of what design thinking is?	58	42
15	Would you like to receive formal training on ATL-based teaching approaches?	88	12

This table presents the extent to which pupil-teachers are aware of various facets of Atal Tinkering Labs (ATLs). A majority (87 %) report having heard about ATLs, indicating that the concept itself is widely recognized among this population; only 13 % are not aware, suggesting minimal total unfamiliarity. In contrast, knowledge regarding eligibility criteria for schools to establish an ATL is substantially lower: only 32 % of respondents know these criteria, while 68 % do not. This gap suggests that although the general existence of ATLs is well-known, specifics about how a school can set one up remain obscure to most. When it comes to direct exposure, 62 % of the pupil-teachers have visited an ATL-equipped school at least once, which means that more than half have seen an ATL environment in practice; nevertheless, 38 % have never done so, revealing a sizeable minority without firsthand experience. Awareness of the financial support provided under ATL is also limited: only 38 % know about the funding mechanisms, and 62 % are not aware, pointing to a need for better dissemination of information about fiscal aspects.

Regarding the focus and pedagogical orientation of ATLs, 77 % correctly identify that ATLs primarily focus on the science domain, while 23 % do not, indicating that most recognize the disciplinary emphasis. When questioned about the learning approach, only 29 % believe that ATL aims to promote passive learning but since 71 % disagree, it is clear that a strong majority understand that ATLs are designed for active rather than passive engagement. Integration of ATL activities into the regular school curriculum is acknowledged by 72 % of pupil-teachers, with 28 % unaware of such integration, suggesting that most see ATLs as part of routine instruction rather than as extracurricular add-ons. The "Do-It-Yourself" (DIY) ethos is another central ATL tenet: 84 % are aware that ATL promotes DIY learning, while 16 % are not, indicating high recognition of hands-on, self-driven experimentation. However, personal participation in ATL activities during their own schooling is low: only 29 % have engaged in such activities, and 71 % have not, reflecting that pupil-teachers' own formative experiences have not widely included ATL-style tasks.

Familiarity with specific technological components is mixed. While 41 % are familiar with basic coding languages taught in ATLs (such as Scratch or Python), 59 % are not, revealing a gap in software literacy among pupil-teachers. Training in ATL technologies is even lower: only 24 % have received any formal training, whereas 76 % have not. This suggests that while some pupil-teachers may know about coding languages superficially, few have undergone structured training to use these tools. Regarding emerging fabrication tools, 42 % are aware of how 3D printers are used in ATL projects, while 58 % are unaware, highlighting limited understanding of hardware applications. 48% are aware about provisions for college students under AIM whereas 52% are not aware about the opportunity which require more awareness programs. Finally, while 58 % know what design thinking entails and how ATLs promote this approach, 42 % remain unfamiliar, yet an overwhelming majority (88 %) express a desire to receive formal training on ATL-based teaching approaches (only 12 % do not). Overall, Table 4.2 reveals that although the concept of ATLs is widely known, detailed understanding of eligibility, funding, integration, hands-on tools, and pedagogical practices is uneven, underscoring areas for targeted teacher-education interventions.

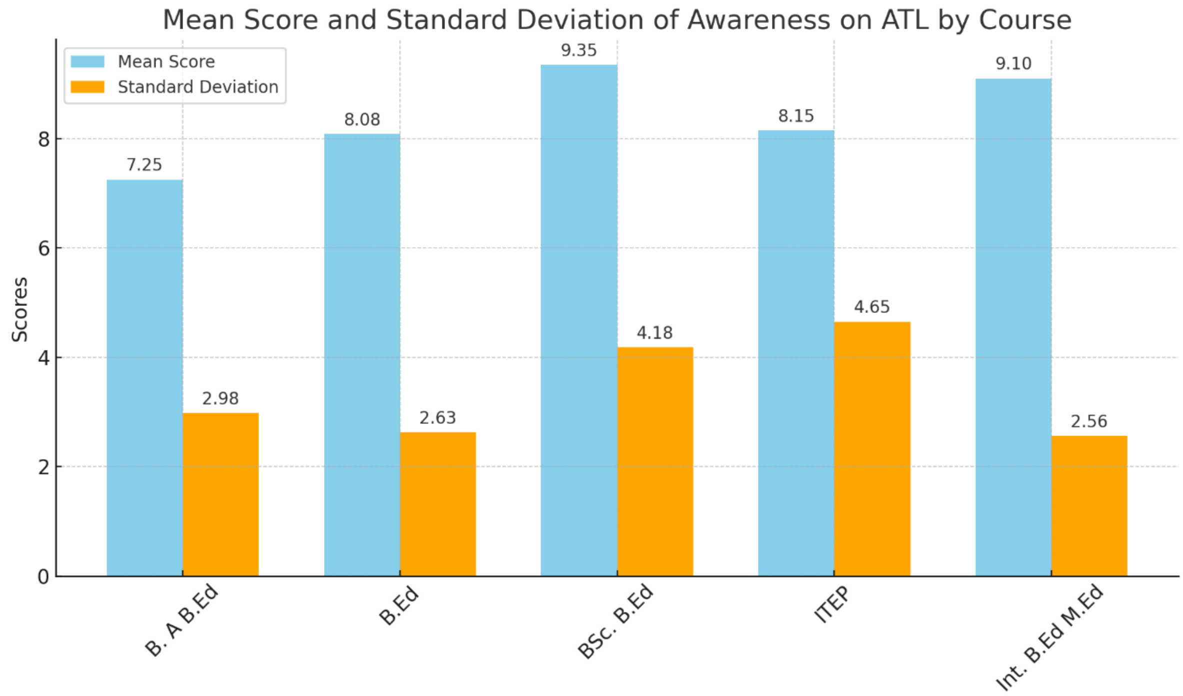
4.2.1 Descriptive Statistics for Awareness on ATL.

Table 4. 3 Course wise Mean Score and Standard Deviation of Awareness on ATL.

Course	N	M	SD
B. A B.Ed	16	7.25	2.98
B.Ed	13	8.08	2.63
BSc. B.Ed	20	9.35	4.18
ITEP	20	8.15	4.65
Int. B.Ed M.Ed	31	9.10	2.56

This table presents the descriptive statistics mean scores (M) and standard deviations (SD) for awareness of Atal Tinkering Lab (ATL) across five teacher-education course groups. The Bachelor of Arts–Bachelor of Education (B.A. B.Ed.) group (n = 16) has a mean awareness score of 7.25 with an SD of 2.98. This indicates that, on average, these pupil-teachers scored just above 7 out of the possible awareness scale, with a moderate spread of about three points around that average. The Bachelor of Education (B.Ed.) group (n = 13) shows a slightly higher mean of 8.08 and a slightly smaller SD of 2.63, suggesting that B.Ed. students not only demonstrated marginally greater awareness but also had somewhat less variability in their scores compared to the B.A. B.Ed. cohort. The Bachelor of Science–Bachelor of Education (BSc. B.Ed.) group (n = 20) recorded the highest mean of 9.35 but also the highest variability (SD = 4.18), indicating that while, on average, these students reported greater awareness of ATL, their individual scores were more dispersed some were very knowledgeable while others lagged behind. The Integrated Teacher Education Program (ITEP) group (n = 20) has a mean of 8.15 with an SD of 4.65, showing a mean roughly comparable to the standalone B.Ed. group but with even wider score dispersion, suggesting substantial differences in awareness levels within this cohort. Finally, the Integrated B.Ed.–M.Ed. (Int. B.Ed. M.Ed.) group (n = 31) has a mean of 9.10 and the lowest SD of 2.56, reflecting both a relatively high average awareness and tighter clustering of scores around that mean. Taken together, these descriptive statistics show that all groups average between approximately 7.25 and 9.35 on the awareness scale, with variability ranging from about 2.56 to 4.65. Although the integrated B.Ed.–M.Ed. and BSc. B.Ed. cohorts appear to report the highest average awareness, the large standard deviations in BSc. B.Ed. and ITEP caution us that within-group differences are substantial, whereas the Int. B.Ed.–M.Ed. group's smaller SD suggests more consistent awareness levels among its members.

Figure 4. 1 Graphical representation of Mean Score and Standard Deviation of Awareness on ATL.



4.2.2 Applying one way ANOVA:

Table 4. 4 ANOVA Table on awareness on ATL.

ANOVA Table						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	55.18	4	13.79	1.1339	0.3453	2.4675
Within Groups	1155.73	95	12.17			
Total	1210.91	99				

A one-way analysis of variance (ANOVA) was conducted to determine whether the mean awareness scores differed significantly across the five course groups. The ANOVA summary reports a Between-Groups sum of squares (SS) of 55.18 with 4 degrees of freedom, yielding a mean square (MS) of 13.79. The Within-Groups SS is 1,155.73 with 95 degrees of freedom, giving an MS of 12.17. The resulting F-statistic is 1.13. When compared against the critical F-value of 2.47 at the 0.05 significance level (df1 = 4, df2 = 95), the observed F (1.13) is substantially lower. Correspondingly, the p-value is 0.3453, well above the conventional alpha threshold of 0.05. In practical terms, this means that although the descriptive means differ (for example, BSc. B.Ed. at 9.35 versus B.A. B.Ed. at 7.25), these observed differences could easily have arisen by chance given the variation within each course group. Thus, there is no statistically significant effect of course type on awareness of ATL. In dissertation terminology, we conclude that "the null hypothesis is not rejected": differences in average awareness scores among the courses are not large enough relative to within-group variability to be deemed statistically significant at the 5% level. Consequently, while descriptive data hint at slight mean differences, the ANOVA indicates that overall, awareness levels are statistically comparable across B.A. B.Ed., B.Ed., BSc. B.Ed., ITEP, and Int. B.Ed.–M.Ed. cohorts.

4.3 Results related to perception of pupil teachers on Atal Tinkering Labs:

Table 4. 5 Perception of pupil teachers on Atal Tinkering Labs.

S. No.	Items	Agree (%)	Disagree (%)	Can't say (%)
1	ATLs contribute to developing 21st-century skills such as problem-solving and critical thinking.	85	1	14
2	ATL fosters innovation and creativity among school students.	82	3	15
3	ATL promotes hands-on and experiential learning.	82	3	15
4	ATL is a necessary step to enhance STEM education in India.	81	3	16
5	ATL should be introduced in all schools, irrespective of location or type.	72	8	20
6	ATL will influence students' future employability and entrepreneurship.	74	1	25

7	ATL should be made a part of the teacher education curriculum.	85	3	12
8	ATL initiatives will make teaching more interesting and effective.	76	4	20
9	ATL promotes inclusive and collaborative learning.	83	4	13
10	ATL-based activities should be encouraged in all subjects, not just science.	79	4	17
11	ATL increases students' motivation and engagement in learning.	78	3	19
12	ATL has a positive effect on students' academic performance.	74	5	21
13	Highly qualified teachers/academicians are essential to be part of AIM.	79	5	16
14	Teachers need regular ATL training to remain effective facilitators.	86	1	13
15	Without proper infrastructure, it is impossible to be a part of the Atal Innovation Mission.	78	7	15

Table 4.5 captures pupil-teachers' perceptions of the value and implementation of ATLs, measured through their levels of agreement, disagreement, or indecision ("Can't say") on multiple statements. First, 85 % agree that ATLs contribute to developing 21st-century skills such as problem-solving and critical thinking; only 1 % disagree, and 14 % are undecided. This indicates that most pupil-teachers recognize ATLs' role in fostering essential modern skills.

Similarly, 82 % agree that ATL fosters innovation and creativity among school students, with only 3 % in disagreement and 15 % unsure reflecting strong confidence in the innovation component, though a modest contingent remains uncertain. The statement that ATL promotes hands-on and experiential learning receives the same level of agreement (82 %), a 3 % disagreement rate, and 15 % “Can’t say,” indicating consensus that ATLs are experiential. In parallel, 81 % agree ATL is a necessary step to enhance STEM education in India (3 % disagree, 16 % can’t say), showing that a strong majority view ATLs as integral to improving STEM, though a nontrivial minority is undecided.

Expanding beyond STEM, 72 % agree that ATL should be introduced in all schools regardless of location or type, 8 % disagree, and 20 % can’t say. While a clear majority favor universal ATL rollout, the relatively higher 20 % undecided suggests that some are uncertain about feasibility or contextual appropriateness for diverse school environments. Regarding future outcomes, 74 % believe ATL will influence students’ future employability and entrepreneurship, only 1 % disagree, and 25 % are unsure. This indicates belief in long-term impact, but a significant quarter are not convinced or lack information. When considering teacher training, 85 % agree ATL should be part of the teacher-education curriculum (3 % disagree, 12 % can’t say), underscoring a strong consensus on integrating ATL pedagogy into professional preparation.

Perceptions of teaching benefits show that 76 % agree ATL initiatives will make teaching more interesting and effective, 4 % disagree, and 20 % are undecided. While most expect ATL to enliven instruction, one-fifth remain unsure. On collaboration and inclusion, 83 % agree ATL promotes inclusive and collaborative learning, 4 % disagree, and 13 % can’t say, indicating robust support for ATL’s social-learning potential, with a small fraction ambivalent. Additionally, 79 % agree that ATL-based activities should be encouraged in all subjects, not just science, 4 % disagree, and 17 % can’t say, signifying broad support for interdisciplinary expansion, though nearly one-fifth are uncertain. Regarding student motivation, 78 % perceive ATL as increasing motivation and engagement (3 % disagree, 19 % can’t say), showing a strong belief in ATL’s motivational effect, yet again a notable “Can’t say” group.

Academic impact perceptions are slightly lower: 74 % agree ATL has a positive effect on students’ academic performance, 5 % disagree, and 21 % can’t say, indicating that while most see academic benefits, over one-fifth are unsure or skeptical. On resource requirements, 79 % agree that highly qualified teachers/academicians are essential to AIM (Atal Innovation

Mission), 5 % disagree, and 16 % are undecided, suggesting that pupil-teachers believe in the importance of expertise, but some are unsure about the level of qualification needed. Most notably, 86 % agree that teachers need regular ATL training to remain effective facilitators (1 % disagree, 13 % can't say), demonstrating near-universal consensus on ongoing professional development. Finally, 78 % agree that without proper infrastructure, it is impossible to be part of AIM (7 % disagree, 15 % can't say), showing recognition of infrastructural prerequisites, but with a small but non-negligible contingent either uncertain or believing otherwise. Taken as a whole, Table 4.5 indicates that pupil-teachers hold largely positive perceptions of ATLs' pedagogical value, scalability, and impact, but each statement features a "Can't say" percentage ranging from 12 % to 25 %, highlighting areas where more information, discussion, or experience might be needed to build unanimous conviction.

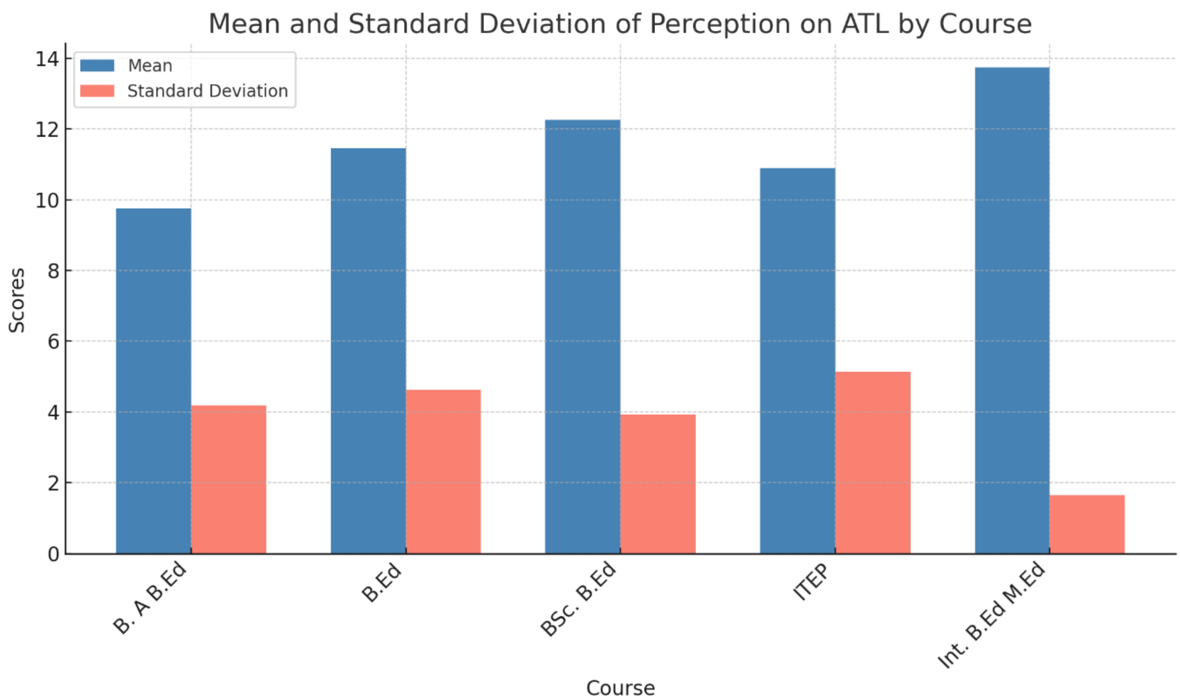
4.3.1 Descriptive Statistics for Perception on ATL.

Table 4. 6 Course wise Mean Score and Standard Deviation of Perception on ATL.

Course	**N**	**M**	**SD**
B. A B.Ed	16	9.75	4.19
B.Ed	13	11.46	4.63
BSc. B.Ed	20	12.25	3.93
ITEP	20	10.90	5.14
Int. B.Ed M.Ed	31	13.74	1.65

This table presents the descriptive statistics for pupil-teachers' perception scores on Atal Tinkering Labs (ATLs) across five teacher-education course categories. The Bachelor of Arts–Bachelor of Education (B.A. B.Ed.) group (n = 16) has a mean perception score of 9.75 with a standard deviation (SD) of 4.19. This indicates that, on average, B.A. B.Ed. students rate their perception of ATL-related constructs at approximately 9.75 units on the measurement scale, with individual scores typically varying by about 4.19 points above or below that mean. The Bachelor of Education (B.Ed.) cohort (n = 13) reports a higher mean of 11.46 and a slightly larger SD of 4.63, suggesting that B.Ed. students, on average, view ATL more positively (or rate perception items more favorably) than the B.A. B.Ed. group, but also exhibit somewhat greater spread in their responses. Among the Bachelor of Science–Bachelor of Education (BSc. B.Ed.) participants (n = 20), the mean perception score is 12.25 with an SD of 3.93; this group not only shows an even higher average perception level than the preceding cohorts but also demonstrates a moderately smaller variability compared to B.Ed. students, indicating more consistency in how BSc. B.Ed. pupil-teachers perceive ATL. The Integrated Teacher Education Program (ITEP) students (n = 20) have a mean of 10.90 and the largest SD of 5.14, reflecting that while their average perception is above that of the B.A. B.Ed. group, individual ITEP respondents' views differ substantially some express very strong perceptions, while others rate much lower. Finally, the Integrated B.Ed.–M.Ed. (Int. B.Ed.–M.Ed.) group (n = 31) records the highest mean of 13.74 and the lowest SD of 1.65, indicating that this cohort both rates ATL most favorably on average and does so with remarkable consistency: most Int. B.Ed.–M.Ed. students' perception scores cluster tightly around 13.74. In sum, these descriptive statistics reveal that average perception scores increase in the order B.A. B.Ed. (9.75), ITEP (10.90), B.Ed. (11.46), BSc. B.Ed. (12.25), and Int. B.Ed.–M.Ed. (13.74), with the Int. B.Ed.–M.Ed. group showing the smallest within-group variability (SD = 1.65) and ITEP showing the largest (SD = 5.14).

Figure 4. 2 Graphical representation of Mean Score and Standard Deviation of Perception on ATL.



4.3.2 Applying one way ANOVA:

Table 4. 7 ANOVA Table for perception on ATL.

ANOVA Table						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	203.92	4	50.98	3.465	0.01093	2.467
Within Groups	1397.72	95	14.71			
Total	1601.64	99				

A one-way analysis of variance was conducted to test whether these apparent differences in mean perception scores among the five course groups are statistically significant. The Between-Groups sum of squares (SS) is 203.92 with 4 degrees of freedom, which yields a Between-Groups mean square (MS) of 50.98. The Within-Groups SS is 1,397.72 with 95 degrees of freedom, giving a Within-Groups MS of 14.71. Dividing the Between-Groups MS by the Within-Groups MS produces an F-statistic of 3.465. When compared against the critical F-value of 2.467 ($\alpha = 0.05$, $df_1 = 4$, $df_2 = 95$), the observed F (3.465) exceeds the critical threshold, and the associated p-value is 0.01093, which is well below the 0.05 significance level. In dissertation-level terms, this result indicates that there is a statistically significant effect of "course type" on pupil-teachers' perception of ATL: the null hypothesis of equal mean perception scores across B.A. B.Ed., B.Ed., BSc. B.Ed., ITEP, and Int. B.Ed.–M.Ed. cohorts can be rejected. Consequently, we conclude that at least one group's mean perception differs meaningfully from the others. Given that the Int. B.Ed.–M.Ed. group has the highest mean (13.74) and the B.A. B.Ed. group the lowest (9.75), the ANOVA suggests these differences are unlikely to be due to random within-group variation alone. However, based solely on the ANOVA table, the main inference is that course affiliation is a significant predictor of how strongly pupil-teachers perceive ATL initiatives.

4.3.3 Applying Pairwise t-Test (assuming unequal variances):

Table 4. 8 Pairwise t-Test for B.A. B.Ed. vs B.Ed.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
B.A. B.Ed.	9.75	-1.033	25.3	0.312	No
B.Ed.	11.46				

The pairwise t-test comparisons reveal how mean perception scores of Atal Tinkering Labs (ATLs) differ (or do not differ) across the five teacher-education programs. First, comparing B.A. B.Ed. (M = 9.75) with B.Ed. (M = 11.46) yields a t-statistic of –1.033 (df ≈ 25.3) and p = 0.312. This p-value far exceeds the 0.05 threshold, indicating that although B.Ed. participants' average perception is numerically higher, the difference is not statistically significant. Although B.Ed. students on average rate ATL slightly more positively than B.A. B.Ed. students, the difference is small and could easily arise by chance. This suggests that graduates of the B.Ed. program and those from the integrated arts-education track hold comparably moderate views on ATL's role in fostering innovation and experiential learning.

Table 4. 9 Pairwise t-Test for B.A. B.Ed. vs B.Sc. B.Ed.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
B.A. B.Ed.	9.75	-1.829	28.6	0.077	No
BSc. B.Ed.	12.25				

From table 4.9, B.A. B.Ed. (M = 9.75) versus BSc. B.Ed. (M = 12.25) gives t = –1.829 (df ≈ 28.6), p = 0.077. Although BSc. B.Ed. students' mean is notably larger, p = 0.077 means it still fails to reach conventional significance. It may hint at stronger STEM-oriented enthusiasm for ATL among science trainees, yet the evidence isn't strong enough to confirm a true program-level gap. Thus, any apparent advantage in BSc. B.Ed.'s perception could be due to sampling variability rather than a true program-level effect.

Table 4. 10 Pairwise t-Test for B.A. B.Ed. vs Int. B.Ed.–M.Ed.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
B.A. B.Ed.	9.75	-3.669	25.8	0.0018	Yes
Int. B.Ed.–M.Ed.	13.74				

The comparison between B.A. B.Ed. and the Integrated B.Ed.–M.Ed. cohort (M = 13.74) yields t = –3.669 (df ≈ 25.8), p = 0.0018. This highly significant result ($p < 0.01$) indicates that Int. B.Ed.–M.Ed. students perceive ATL substantially more positively than B.A. B.Ed. students. The Int. B.Ed.–M.Ed. group's mean (13.74) is nearly four points above that of the B.A. B.Ed. group, this highly significant difference suggests that the more advanced, research-oriented integrated program effectively fosters deeper appreciation of ATL's potential in developing 21st-century skills.

Table 4. 11 Pairwise t-Test for B.A. B.Ed. vs ITEP.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
B.A. B.Ed.	9.75	-0.740	27.6	0.4645	No
ITEP	10.90				

The comparison between B.A. B.Ed. and ITEP (M = 10.90) yields t = –0.740 (df ≈ 27.6), p = 0.4645, indicating no significant difference. B.A. B.Ed. and ITEP students hold fairly similarly and relatively lower perception scores.

Table 4. 12 Pairwise t-Test for B.Ed. vs BSc. B.Ed.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
B.Ed.	11.46	-0.507	27.1	0.6173	No
BSc. B.Ed.	12.25				

The comparison, B.Ed. versus BSc. B.Ed. yields t = –0.507 (df ≈ 27.1), p = 0.6173. Despite BSc. B.Ed. having a higher mean (12.25 vs. 11.46), the difference again fails significance. Both program B.Ed. and BSc. B.Ed. share comparable attitudes toward the value of ATL in teacher education.

Table 4. 13 Pairwise t-Test for B.Ed. vs Int. B.Ed.–M.Ed.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
B.Ed.	11.46	-1.730	31.7	0.1067	No
Int. B.Ed.–M.Ed.	13.74				

B.Ed. versus Int. B.Ed.–M.Ed. yields t = –1.730 (df ≈ 31.7), p = 0.1067. Here, although the Int. B.Ed.–M.Ed. mean exceeds B.Ed. by over two points, p = 0.1067 means it does not meet the 0.05 criterion. Thus, B.Ed. and Int. B.Ed.–M.Ed. perceptions cannot be declared significantly different at the 5 percent level.

Table 4. 14 Pairwise t-Test for B.Ed. vs ITEP.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
B.Ed.	11.46	0.326	22.7	0.7470	No
ITEP	10.90				

B.Ed. versus ITEP yields t = 0.326 (df ≈ 22.7), p = 0.7470, confirming that these two cohorts hold statistically equivalent attitude levels toward ATL.

Table 4. 15 Pairwise t-Test for BSc. B.Ed. vs Int. B.Ed.-M.Ed.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
BSc. B.Ed.	12.25	-1.608	37.2	0.1213	No
Int. B.Ed.–M.Ed.	13.74				

BSc. B.Ed. versus Int. B.Ed.–M.Ed. gives t = –1.608 (df ≈ 37.2), p = 0.1213. Although Int. B.Ed.–M.Ed. (13.74) outperforms BSc. B.Ed. (12.25) descriptively, p = 0.1213 indicates the gap is not statistically meaningful.

Table 4. 16 Pairwise t-Test for BSc. B.Ed. vs ITEP.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
BSc. B.Ed.	12.25	0.933	35.8	0.3571	No
ITEP	10.90				

BSc. B.Ed. versus ITEP yields t = 0.933 (df ≈ 35.8), p = 0.3571, showing no significant difference between these two.

Table 4. 17 Pairwise t-Test for Int. B.Ed.-M.Ed. vs ITEP.

Group	Mean	t-statistic	df	p-value	Significant (α=0.05)
Int. B.Ed.–M.Ed.	13.74	2.395	33.3	0.0258	Yes
ITEP	10.90				

Finally, Int. B.Ed.–M.Ed. versus ITEP yields t = 2.395 (df ≈ 33.3), p = 0.0258, indicating a statistically significant difference. Int. B.Ed.–M.Ed. students hold markedly higher perception scores than ITEP. This underscores that the depth and duration of exposure in the integrated master's program.

In sum, only two comparisons reach statistical significance Int. B.Ed.–M.Ed. versus B.A. B.Ed. and Int. B.Ed.–M.Ed. versus ITEP underscoring that the Integrated B.Ed.–M.Ed. program stands out with a consistently more positive perception of ATL, while all other course-pair comparisons do not demonstrate reliable differences at α = 0.05.

Overall, the data paint a coherent picture: pupil-teachers are generally aware of Atal Tinkering Labs (ATLs) at a broad, conceptual level, and they hold largely positive perceptions of ATL's pedagogical value, but their detailed knowledge and practical experience vary considerably, and these variations are shaped in part by their teacher-education program. In the awareness tables, more than eight in ten pupil-teachers have heard of ATLs, recognize their science-focused, hands-on, "Do It Yourself" orientation, and understand that ATL activities are integrated into the school curriculum. However, fewer than half know about specific eligibility criteria, funding mechanisms, or detailed tech components such as coding languages and 3D printing. Moreover, only about a third have personally participated in ATL activities, and under a quarter have received formal training in ATL technologies. These gaps suggest that, although the concept of ATL is familiar, many pupil-teachers lack deeper, actionable knowledge especially regarding how to establish an ATL in a school or guide students in using its specialized tools.

Perception data reinforce the general positivity toward ATL: large majorities agree that ATL contributes to 21st-century skill development, fosters innovation and experiential learning, and should be incorporated into teacher-education curricula. Most also believe ATL will enhance STEM education, support future employability and entrepreneurship, promote inclusion and collaboration, and motivate students across all subjects. Notably, nearly nine in ten respondents assert that ongoing ATL training for teachers is essential and that proper infrastructure is a prerequisite for participation in the Atal Innovation Mission. At the same time, each perception item attracted a non-negligible "Can't say" response (ranging from about 12% to 25%), implying that even among those who agree there remains some uncertainty or lack of firsthand experience needed to form a decisive opinion.

When awareness scores are disaggregated by teacher-education course, descriptive statistics show that all five cohorts (B.A. B.Ed., B.Ed., BSc. B.Ed., ITEP, and Int. B.Ed.–M.Ed.) cluster within a similar score range (approximately 7.25 to 9.35), with differences in means largely tempered by within-group variability. The one-way ANOVA confirms that these mean differences are not statistically significant: awareness of ATL does not depend on course affiliation in a meaningful way. In contrast, perception scores do differ significantly by course. Integrated B.Ed.–M.Ed. students report the highest and most consistent perception scores ($M \approx 13.74$, $SD \approx 1.65$), while B.A. B.Ed. students show the lowest ($M \approx 9.75$, $SD \approx 4.19$). BSc. B.Ed. and B.Ed. cohorts occupy the middle range, with ITEP students displaying the greatest spread in perceptions. The ANOVA's p-value (≈ 0.011) indicates that at least some course groups differ reliably, and given the means, the strongest contrast is between Int. B.Ed.–M.Ed. versus B.A. B.Ed. cohorts.

A series of t-tests (assuming unequal variances) was conducted to pinpoint which course pairs differ significantly in mean perception. The t-test tables reveal two statistically significant pairwise differences: the Int. B.Ed.–M.Ed. cohort's mean perception is significantly higher than both the B.A. B.Ed. and the ITEP cohorts. All other pairwise comparisons do not reach the 0.05 significance threshold. This pattern corroborates the ANOVA finding that the Int. B.Ed.–M.Ed. program stands out with significantly stronger, more uniform ATL perceptions compared to certain other programs. This suggests that more advanced or integrated teacher-education programs may foster stronger, more uniform confidence in ATL's objectives and benefits, whereas standalone or more generalist courses leave greater heterogeneity in how ATL is perceived.

Taken together, these findings imply several key takeaways. First, while ATL concepts have permeated teacher-education broadly, there remains a pronounced need for deeper, more hands-on training especially around eligibility, funding, and technology tools so that pupil-teachers can move from general awareness to functional expertise. Second, teacher-education programs that integrate ATL-specific modules (such as the Int. B.Ed.–M.Ed.) appear to cultivate consistently positive perceptions, suggesting that curricular emphasis matters: the more immersive or specialized the program, the stronger and more uniform the belief in ATL's value. Conversely, courses without such emphasis show wider variability and, in some cases, lower average perceptions, indicating that ATL concepts may not yet be institutionalized uniformly across all teacher-education streams. Finally, because perception and readiness to implement ATL differs by program type, policy efforts aimed at scaling ATL should consider tailored professional-development initiatives that address the specific gaps observed in each cohort ensuring that all incoming teachers, regardless of their course affiliation, emerge equally prepared to leverage ATL for innovative, experiential STEM education.