ಕರ್ನಾಟಕ ವಿಧಾನ ಪರಿಷತ್ತು

ಚುಕ್ಕೆ ಗುರುತಿಲ್ಲದ ಪ್ರಶ್ನೆ ಸಂಖ್ಯೆ : 1543 (1750)

ಸದಸ್ಯರ ಹೆಸರು : ಶ್ರೀ. ಗೋವಿಂದ ರಾಜು

(ಮಾನ್ಯ ವಿಧಾನಸಭೆಯಿಂದ ಚುನಾಯಿತರಾದ ಸದಸ್ಯರು)

ಉತ್ತರಿಸಬೇಕಾದ ದಿನಾಂಕ : 23.03.2026

ಉತ್ತರಿಸುವ ಸಚಿವರು : ಮಾನ್ಯ ಶಾಲಾ ಶಿಕ್ಷಣ ಮತ್ತು ಸಾಕ್ಷರತಾ ಸಚಿವರು

ಕ್ರ ಸಂ	ಪ್ರಶ್ನೆ	ಉತ್ತರ
ಅ)	ರಾಜ್ಯದ ಶೇ.50.52 ರಷ್ಟು ಶಾಲೆಗಳಲ್ಲಿ ಕಂಪ್ಯೂಟರ್ ಅಥವಾ ಟ್ಯಾಬ್ ಗಳೇ ಇಲ್ಲದೆ ಇರುವುದು ಹಾಗೂ ಶಾಲೆಗಳಲ್ಲಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯಗಳು ಕಾರ್ಯನಿರ್ವಹಿಸದೇ ಇದ್ದು, ಶೇ.55.58 ಶಾಲೆಗಳಲ್ಲಿ ವಿಜ್ಞಾನ ಸಂಬನೂಲ ಪುಸ್ತಕಗಳೇ ಲಭ್ಯವಿಲ್ಲ ಎಂಬುದು ಸರ್ಕಾರದ ಗಮನಕ್ಕೆ ಬಂದಿದೆಯೇ:	• 2024-25ನೇ ಸಾಲಿನಲ್ಲಿ, ಹೆಚ್ಚು ದಾಖಲಾತಿ ಹೊಂದಿರುವ 262 ಸರ್ಕಾರಿ Elementary ಶಾಲೆಗಳು, 359 ಸರ್ಕಾರಿ ಪ್ರೌಢಶಾಲೆಗಳಿಗೆ 04 ರಿಂದ 05 AIO ಕಂಪ್ಯೂಟರ್‌ಗಳು, 01 ಲ್ಯಾಪ್‌ಟಾಪ್, ಯುಪಿಎಸ್ ವಿತ್ ಬ್ಯಾಟರಿಗಳು ಮತ್ತು ಪ್ರೊಜೆಕ್ಟರ್ ಒಳಗೊಂಡಂತೆ ಕಂಪ್ಯೂಟರ್ ಲ್ಯಾಬ್ ಅನ್ನು ಸ್ಥಾಪಿಸಲಾಗಿದೆ.

• ರಾಜ್ಯದಲ್ಲಿ ಒಟ್ಟು 4880 ಸರ್ಕಾರಿ ಪ್ರೌಢಶಾಲೆಗಳಿದ್ದು, ಇದರಲ್ಲಿ 2024-25 ರವರೆಗೆ 3069 ಶಾಲೆಗಳಲ್ಲಿ ಕಂಪ್ಯೂಟರ್ ಲ್ಯಾಬ್ ಸ್ಥಾಪಿಸಲಾಗಿದ್ದು, 4445 ಶಾಲೆಗಳಿಗೆ ಲ್ಯಾಪ್‌ಟಾಪ್, 3221 ಶಾಲೆಗಳಿಗೆ ಪ್ರೊಜೆಕ್ಟರ್‌ಗಳನ್ನು ಒದಗಿಸಿ ಸ್ಮಾರ್ಟ್ ಕ್ಲಾಸ್‌ಗಳಂತೆ ಬಳಸಲು ಕ್ರಮವಹಿಸಿದೆ.

• ಸಮಗ್ರ ಶಿಕ್ಷಣ ಕರ್ನಾಟಕದ ಯೋಜನೆಯ ICT & Digital initiatives ಚಟುವಟಿಕೆಯಡಿಯಲ್ಲಿ ರಾಜ್ಯದ ಒಟ್ಟು 3862 ಸರ್ಕಾರಿ ಶಾಲೆಗಳಲ್ಲಿ ಸ್ಮಾರ್ಟ್ ಕ್ಲಾಸ್ ರೂಮ್ ಗಳನ್ನು ಸ್ಥಾಪಿಸುವ ಕಾರ್ಯ ಪ್ರಗತಿಯಲ್ಲಿರುತ್ತದೆ (ಪ್ರಾಥಮಿಕ-2957, ಪ್ರೌಢ-810, ಮತ್ತು ಕೆ.ಜಿ.ಬಿ.ವಿ-95.)

• 2025-26ನೇ ಸಾಲಿನಲ್ಲಿ ಸಮಗ್ರ ಶಿಕ್ಷಣ ಕರ್ನಾಟಕದ ಯೋಜನೆಯಡಿ 854 ಸರ್ಕಾರಿ ಶಾಲೆಗಳಲ್ಲಿ ಕಂಪ್ಯೂಟರ್ ಲ್ಯಾಬ್ ಸ್ಥಾಪಿಸುವ ಕಾರ್ಯ ಪ್ರಗತಿಯಲ್ಲಿದೆ.

• 2023-24 ಮತ್ತು 2024-25 ನೇ ಸಾಲುಗಳಲ್ಲಿ ಕೆ.ಕೆ.ಆರ್.ಡಿ.ಬಿ ಅನುದಾನದಡಿ ಒಟ್ಟು 273 ಶಾಲೆಗಳಲ್ಲಿ ಸ್ಮಾರ್ಟ್ ಕ್ಲಾಸ್‌ಗಳನ್ನು ರೂ.9.76 ಕೋಟಿ ವೆಚ್ಚದಲ್ಲಿ ಸ್ಥಾಪಿಸಲಾಗಿದೆ.

• 2025-26 ನೇ ಸಾಲಿನಲ್ಲಿ ಕೆ.ಕೆ.ಆರ್.ಡಿ.ಬಿ ಅನುದಾನದಡಿ 242 ಸರ್ಕಾರಿ ಶಾಲೆಗಳಲ್ಲಿ ರೂ. 3.22 ಕೋಟಿ ಅನುದಾನದೊಂದಿಗೆ ಸ್ಮಾರ್ಟ್ ಕ್ಲಾಸ್‌ಗಳನ್ನು ಸ್ಥಾಪಿಸುವ ಕಾರ್ಯ ಅನುಮೋದನೆಹಂತದಲ್ಲಿದೆ. |

- 2024-25ನೇ ಸಾಲಿಗೆ 308 ಕೆ.ಪಿ.ಎಸ್. ಶಾಲೆಗಳಲ್ಲಿ ಕಂಪ್ಯೂಟರ್ ಲ್ಯಾಬ್ ಅನ್ನು ರೂ.439.20 ಲಕ್ಷಗಳ ಅನುದಾನದಲ್ಲಿ ಸ್ಥಾಪಿಸಲಾಗಿದೆ. ಸರ್ಕಾರದ ಆದೇಶ ಪ್ರತಿಯನ್ನು ಅಡಕಗೊಳಿಸಿದೆ.

- 2024-25ನೇ ಸಾಲಿಗೆ 308 ಕೆ.ಪಿ.ಎಸ್. ಶಾಲೆಗಳಲ್ಲಿ ಸ್ಮಾರ್ಟ್‌ಕ್ಲಾಸ್ ಅನ್ನು ರೂ. 646.80 ಲಕ್ಷಗಳ ಅನುದಾನದಲ್ಲಿ ಸ್ಥಾಪಿಸಲಾಗಿದೆ.

- 2023-24, 2024-25 ಮತ್ತು 2025-26 ನೇ ಸಾಲಿಗೆ ಒಟ್ಟು 69 ಪಿ.ಎಂ.ಶ್ರೀ ಶಾಲೆಗಳಲ್ಲಿ ಕಂಪ್ಯೂಟರ್ ಲ್ಯಾಬ್ ಅನ್ನು ರೂ. 345.00 ಲಕ್ಷಗಳ ಅನುದಾನದಲ್ಲಿ ಅನುಷ್ಠಾನಗೊಳಿಸಲಾಗಿದೆ.

- 2023-24, 2024-25 ಮತ್ತು 2025-26 ನೇ ಸಾಲಿಗೆ ಒಟ್ಟು 175 ಪಿ.ಎಂ.ಶ್ರೀ ಶಾಲೆಗಳಲ್ಲಿ ಸ್ಮಾರ್ಟ್‌ಕ್ಲಾಸ್ ರೂಂಗಳನ್ನು ರೂ.745.00 ಲಕ್ಷಗಳ ಅನುದಾನದಲ್ಲಿ ಅನುಷ್ಠಾನಗೊಳಿಸಲಾಗಿದೆ.

- 2025-26 ನೇ ಆಯವ್ಯಯ ಘೋಷಣೆ ಅನ್ವಯ 218 ಸರ್ಕಾರಿ ಶಾಲೆಗಳಲ್ಲಿ ಕಂಪ್ಯೂಟರ್ ಲ್ಯಾಬ್ ಸ್ಥಾಪನೆ ಕಾರ್ಯ ಪ್ರಗತಿಯಲ್ಲಿರುತ್ತದೆ.

ಕ್ರ. ಸಂ	ಯೋಜನೆ	ಶಾಲೆಗಳ ಸಂಖ್ಯೆ	ಒಟ್ಟು ಅನುದಾನ
1	SSK	262	1676.80 ಲಕ್ಷಗಳು
2	SSK	359	1843.50 ಲಕ್ಷಗಳು
3	SSK	3862	9154.80 ಲಕ್ಷಗಳು
4	SSK	854	4429.20 ಲಕ್ಷಗಳು
6	KKRDB	273	976.46 ಲಕ್ಷಗಳು
7	KPS	308	1086.00 ಲಕ್ಷಗಳು
8	PMSHRI	69	345.00 ಲಕ್ಷಗಳು
9	PMSHRI	175	745.00 ಲಕ್ಷಗಳು
ಒಟ್ಟು ಶಾಲೆಗಳ ಸಂಖ್ಯೆ		6162	

ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯಗಳ ಕುರಿತು :

- 2023-24 ಮತ್ತು 2024-25ನೇ ಸಾಲುಗಳಲ್ಲಿ ಕೆ.ಕೆ.ಆರ್.ಡಿ.ಬಿ ಅನುದಾನದಡಿ ಒಟ್ಟು 340 ಶಾಲೆಗಳಲ್ಲಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯಗಳನ್ನು ರೂ. 33.09 ಕೋಟಿ ವೆಚ್ಚದಲ್ಲಿ ಸ್ಥಾಪಿಸಲಾಗಿದೆ.

- 2025-26ನೇ ಸಾಲಿನಲ್ಲಿ ಕೆ.ಕೆ.ಆರ್.ಡಿ.ಬಿ ಅನುದಾನದಡಿ 2 ಸರ್ಕಾರಿ ಶಾಲೆಗಳಲ್ಲಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯಗಳನ್ನು ಸ್ಥಾಪಿಸುವ ಕಾರ್ಯ ಪ್ರಗತಿಯಲ್ಲಿದೆ.

- 2024-25ನೇ ಸಾಲಿನಲ್ಲಿ ಆಯವ್ಯಯದಂತೆ ಪ್ರತಿ ಸರ್ಕಾರಿ ಪ್ರೌಢಶಾಲೆಗೆ ರೂ.2.032 ಲಕ್ಷಗಳಂತೆ ಒಟ್ಟು 250 ಸರ್ಕಾರಿ ಪ್ರೌಢಶಾಲೆಗಳಲ್ಲಿ ರೂ. 508.00 ಲಕ್ಷಗಳ ಅನುದಾನದಲ್ಲಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯ ಯೋಜನೆಯನ್ನು ಅನುಷ್ಠಾನಗೊಳಿಸಲಾಗಿದೆ.

- 2025-26ನೇ ಆಯವ್ಯಯ ಘೋಷಣೆ ಅನ್ವಯ 250 ಶಾಲೆಗಳಲ್ಲಿ ರೂ. 508.00 ಲಕ್ಷಗಳ ಅನುದಾನದಲ್ಲಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯ ಯೋಜನೆಯನ್ನು ಅನುಷ್ಠಾನಗೊಳಿಸಲಾಗಿದೆ.

- 2025-26ನೇ ಸಾಲಿನ PAB ಅನುಮೋದನೆಯಂತೆ ರಾಜ್ಯದ 347 ಸರ್ಕಾರಿ ಪ್ರೌಢಶಾಲೆಗಳಲ್ಲಿ ರೂ.1.00 ಲಕ್ಷಗಳ ಘಟಕ ವೆಚ್ಚದಲ್ಲಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯ ಚಟುವಟಿಕೆಯನ್ನು ಅನುಷ್ಠಾನಗೊಳಿಸಿದೆ. ಈ ಚಟುವಟಿಕೆಯಡಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯಕ್ಕೆ ಅಗತ್ಯವಾದ Lab Equipments & Consumables ಗಳನ್ನು ಖರೀದಿಸಲು ಕ್ರಮವಹಿಸಲಾಗುತ್ತಿದೆ.

- 71 ಪಿ.ಎಂ.ಶ್ರೀ ಶಾಲೆಗಳಲ್ಲಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯಗಳನ್ನು ರೂ.1177.05 ಲಕ್ಷಗಳ ಅನುದಾನದಲ್ಲಿ ಅನುಷ್ಠಾನಗೊಳಿಸಲಾಗಿದೆ.
- 106 ಪಿ.ಎಂ.ಶ್ರೀ ಶಾಲೆಗಳಲ್ಲಿ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯಗಳನ್ನು ರೂ. 188.40 ಲಕ್ಷಗಳ ಅನುದಾನದಲ್ಲಿ ಅನುಷ್ಠಾನಗೊಳಿಸಲಾಗಿದೆ

| ಕ್ರ. ಸಂ	ಯೋಜನೆ	ಶಾಲೆಗಳ ಸಂಖ್ಯೆ	ಒಟ್ಟು ಅನುದಾನ
1	KKRDB	340	3309.01 ಲಕ್ಷಗಳು
2	2024-25 BUDGET PARA	250	508.00 ಲಕ್ಷಗಳು
3	2025-26 BUDGET PARA	250	508.00 ಲಕ್ಷಗಳು
4	SSK-RMSA	347	347.00 ಲಕ್ಷಗಳು
3	PMSHRI	71	1177.05 ಲಕ್ಷಗಳು
4	PMSHRI	106	188.40 ಲಕ್ಷಗಳು
ಒಟ್ಟು ಶಾಲೆಗಳ ಸಂಖ್ಯೆ		1364	

ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯ ಬಳಕೆಯ ಕುರಿತು "ಪ್ರಯೋಗದರ್ಶಿ" ಕೈಪಿಡಿಯನ್ನು ಡಿ.ಎಸ್.ಇ.ಆರ್.ಟಿ ಹಂತದಲ್ಲಿ ಸಿದ್ಧಪಡಿಸಿ ಅಧಿಕೃತ ವೆಬ್‌ಸೈಟ್‌ನಲ್ಲಿ ಪ್ರಕಟಿಸಲಾಗಿರುತ್ತದೆ. ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯ ಹೊಂದಿರುವ ಶಾಲೆಗಳಲ್ಲಿನ ವಿಜ್ಞಾನ ಶಿಕ್ಷಕರಿಗೆ ಪ್ರಯೋಗಾಲಯ

		ಉಪಕರಣಗಳ ಬಳಕೆಯ ಕುರಿತು ರಾಜ್ಯ ಮತ್ತು ಜಿಲ್ಲಾ ಹಂತದಲ್ಲಿ ತರಬೇತಿಯನ್ನು ಹಾಗೂ ಪ್ರಯೋಗದರ್ಶಿ ಕೈಪಿಡಿಯನ್ನು ನೀಡುವ ಮೂಲಕ ವಿಜ್ಞಾನ ತರಗತಿಗಳಲ್ಲಿ ಪ್ರಯೋಗಗಳನ್ನು ಯಶಸ್ವಿಯಾಗಿ ಶಿಕ್ಷಕರು ನಿರ್ವಹಿಸುವಂತೆ ಕ್ರಮವಹಿಸಲಾಗಿದೆ.
ಅ)	ಇದರಿಂದ ರಾಜ್ಯದ ವಿಜ್ಞಾನ ಶಿಕ್ಷಣದ ಗುಣಮಟ್ಟದ ಮೇಲೆ ಕೆಟ್ಟ ಪರಿಣಾಮ ಬೀರುವುದಿಲ್ಲವೇ: ಇದರ ಬಗ್ಗೆ ಸರ್ಕಾರ ಯಾವ ಕ್ರಮ ತೆಗೆದುಕೊಂಡಿದೆ;	ರಾಜ್ಯದ ವಿಜ್ಞಾನ ಶಿಕ್ಷಣದ ಗುಣಮಟ್ಟದಮೇಲೆ ಯಾವುದೇ ನಕರಾತ್ಮಕ ಪರಿಣಾಮ ಬೀರದಂತೆ ಈ ಕೆಳಕಂಡ ಹಲವಾರು ಉಪಕ್ರಮಗಳನ್ನು ಅನುಷ್ಠಾನಗೊಳಿಸಲಾಗಿದೆ.

• ಪ್ರಶ್ನೆ (ಅ) ರಲ್ಲಿ ಲ್ಯಾಪ್‌ಟಾಪ್, ಸ್ಮಾರ್ಟ್ ಕ್ಲಾಸ್ ಹಾಗೂ ವಿಜ್ಞಾನ ಪ್ರಯೋಗಾಲಯಗಳ ಸ್ಥಾಪನೆ ಕುರಿತು ವಿವರಿಸಲಾಗಿದೆ.

• ಪ್ರಯೋಗಾಲಯ ಬಳಕೆ ಮತ್ತು ತರಗತಿ ಬೋಧನೆಗೆ ಅನುಕೂಲವಾಗುವಂತೆ ವಿಜ್ಞಾನ ಶಿಕ್ಷಕರಿಗೆ IISc (Indian Institute of Science) ಮೂಲಕ ತರಬೇತಿ ನೀಡಲಾಗುತ್ತಿದೆ.

• ಶಾಲಾ ಮಕ್ಕಳಲ್ಲಿ ವೈಜ್ಞಾನಿಕ ಪ್ರಜ್ಞೆ, ವಿಜ್ಞಾನ ಹಾಗೂ ತಂತ್ರಜ್ಞಾನ ಕೌಶಲ್ಯಗಳನ್ನು ಉತ್ತೇಜಿಸಲು ವಿವಿಧ ಹಂತಗಳಲ್ಲಿ ವಿಜ್ಞಾನ ವಸ್ತು ಪ್ರದರ್ಶನಗಳನ್ನು ಆಯೋಜಿಸಲಾಗುತ್ತಿದೆ.

• INSPIRE Award – ಕಾರ್ಯಕ್ರಮ:- DST& NIF ಸಹಯೋಗದೊಂದಿಗೆ ಪ್ರತಿ ವರ್ಷ ವಿದ್ಯಾರ್ಥಿಗಳ ನಾವೀನ್ಯಯುತ ಅನ್ವೇಷಣೆಗಳನ್ನು ಆಯ್ಕೆ ಮಾಡಿ ರೂ.10,000/-ಗಳ ಅವಾರ್ಡ್ ನೊಂದಿಗೆ ಜಿಲ್ಲಾ ಮಟ್ಟದ ವಸ್ತುಪ್ರದರ್ಶನ ನಂತರ ಕ್ರಮವಾಗಿ ರಾಜ್ಯ ಹಾಗೂ ರಾಷ್ಟ್ರಮಟ್ಟದ ಸ್ಪರ್ಧೆಗಳಲ್ಲಿ ಭಾಗವಹಿಸಲು ಅವಕಾಶ ನೀಡುವ ಮೂಲಕ ವೈಜ್ಞಾನಿಕ ಚಿಂತನೆ ಹಾಗೂ ಸಂಶೋಧನಾ ಪ್ರವೃತ್ತಿ ಹೆಚ್ಚಿಸಲು ಕ್ರಮವಹಿಸಲಾಗುತ್ತಿದೆ.

• RAS- Rastriya Aavishkar Saptah:- DESM /NCERT ಸಹಯೋಗದಲ್ಲಿ ಪ್ರತಿ ವರ್ಷ ಆಯ್ಕೆ ಮಾಡಲಾದ ವೈಜ್ಞಾನಿಕ Theme (Tree Plantation, Water Conservation etc) ಗಳನ್ನು ಆಧರಿಸಿದ ಚಟುವಟಿಕೆಗಳನ್ನು ಶಾಲಾ ಹಂತದಲ್ಲಿ ಆಯೋಜಿಸುವ ಮೂಲಕ ಮಕ್ಕಳಲ್ಲಿ ನೈಸರ್ಗಿಕ ಸಂಪನ್ಮೂಲ ಬಳಕೆ ಹಾಗೂ ಸಂರಕ್ಷಣೆ ಕುರಿತು ಜಾಗೃತಿ ಮೂಡಿಸಲಾಗುತ್ತಿದೆ.

• RSBVP- Rajya Stariya Bala Vaigyanik Pradarshini:- DESM /NCERT ಸಹಯೋಗದಲ್ಲಿ ಪ್ರತಿ ವರ್ಷ ಆಯ್ಕೆ ಮಾಡಲಾದ ಸುಸ್ಥಿರ ಭವಿಷ್ಯಕ್ಕಾಗಿ ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ ಆಧರಿಸಿದ Themeಗೆ ಅನುಗುಣವಾಗಿ ಶಾಲಾ ಹಂತದಿಂದ ರಾಷ್ಟ್ರ ಹಂತದವರೆಗೆ ವಿಜ್ಞಾನ ವಸ್ತುಪ್ರದರ್ಶನವನ್ನು ಆಯೋಜಿಸಿ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ವಿಪುಲವಾದ ಅನುಭವ ಹಾಗೂ ನಾವೀನ್ಯಯುತವಾದ ಆವಿಷ್ಕಾರಗಳಿಗೆ ಅವಕಾಶ ನೀಡಲಾಗಿದೆ. |

ಇ)	"ಕರ್ನಾಟಕದಲ್ಲಿ ವಿಜ್ಞಾನ ಶಿಕ್ಷಕರ ವೃತ್ತಿಪರ, ಅಭಿವೃದ್ಧಿ ಮೌಲ್ಯಮಾಪನ ಮತ್ತು ಸಂಪನ್ಮೂಲದ ಬಳಕೆ ಎಂಬ ಅಧ್ಯಯನವನ್ನು" ಡಿಎಸ್ಇಆರ್ಟಿ ಸಂಸ್ಥೆಯ ಮೂಲಕ ಮಾಡಲಾಗಿದೆಯೇ; ಹಾಗಿದ್ದಲ್ಲಿ ವರದಿಯಂತೆ ಕ್ರಮ ತೆಗೆದುಕೊಳ್ಳಲಾಗಿದೆಯೇ; ವರದಿಯ ಪ್ರತಿಯನ್ನು ಒದಗಿಸುವುದು;	ಹೌದು. ಕರ್ನಾಟಕದಲ್ಲಿ ವಿಜ್ಞಾನ ಶಿಕ್ಷಕರ ವೃತ್ತಿಪರ ಅಭಿವೃದ್ಧಿ ಮತ್ತು ಸಂಪನ್ಮೂಲದ ಬಳಕೆ ಬಗ್ಗೆ ಅಧ್ಯಯನವನ್ನು ಡಿ.ಎಸ್.ಇ.ಆರ್.ಟಿ ಮೂಲಕ ಕೈಗೊಳ್ಳಲಾಗಿರುತ್ತದೆ. ಸದರಿ ಅಧ್ಯಯನದ ವರದಿಯ ಪ್ರತಿಯನ್ನು ಅನುಬಂಧ-1 ರಲ್ಲಿ ಇರಿಸಿದೆ.
ಈ)	ವರದಿಯಲ್ಲಿ ನೀಡಿರುವ ಶಿಫಾರಸ್ಸು ಮತ್ತು ಸಲಹೆಗಳನ್ನು ಅನುಸರಿಸಲು ಸರ್ಕಾರ ಕಾರ್ಯಪ್ರವೃತ್ತವಾಗಿದೆಯೇ ?	ವರದಿಯಲ್ಲಿ ನೀಡಿರುವ ಶಿಫಾರಸ್ಸು ಮತ್ತು ಸಲಹೆಗಳನ್ವಯ ಶಿಕ್ಷಕರ ತರಬೇತಿಗಳಲ್ಲಿ ವಿಜ್ಞಾನ ಕಲಿಕೆಯಲ್ಲಿ ವಿದ್ಯಾರ್ಥಿಗಳು ಹೆಚ್ಚಿನ ಆಸಕ್ತಿಯನ್ನು ಹೊಂದಲು ವಹಿಸಬೇಕಾದ ಕ್ರಮಗಳ ಕುರಿತು ವಿಜ್ಞಾನ ಶಿಕ್ಷಕರಿಗೆ ಮಾರ್ಗದರ್ಶನ ನೀಡಲಾಗಿದೆ.

ಸಂಖ್ಯೆ : EP 16 EGOV 2026

(ಎಸ್. ಮಧು ಬಂಗಾರಪ್ಪ)
ಶಾಲಾ ಶಿಕ್ಷಣ ಮತ್ತು ಸಾಕ್ಷರತಾ ಸಚಿವರು
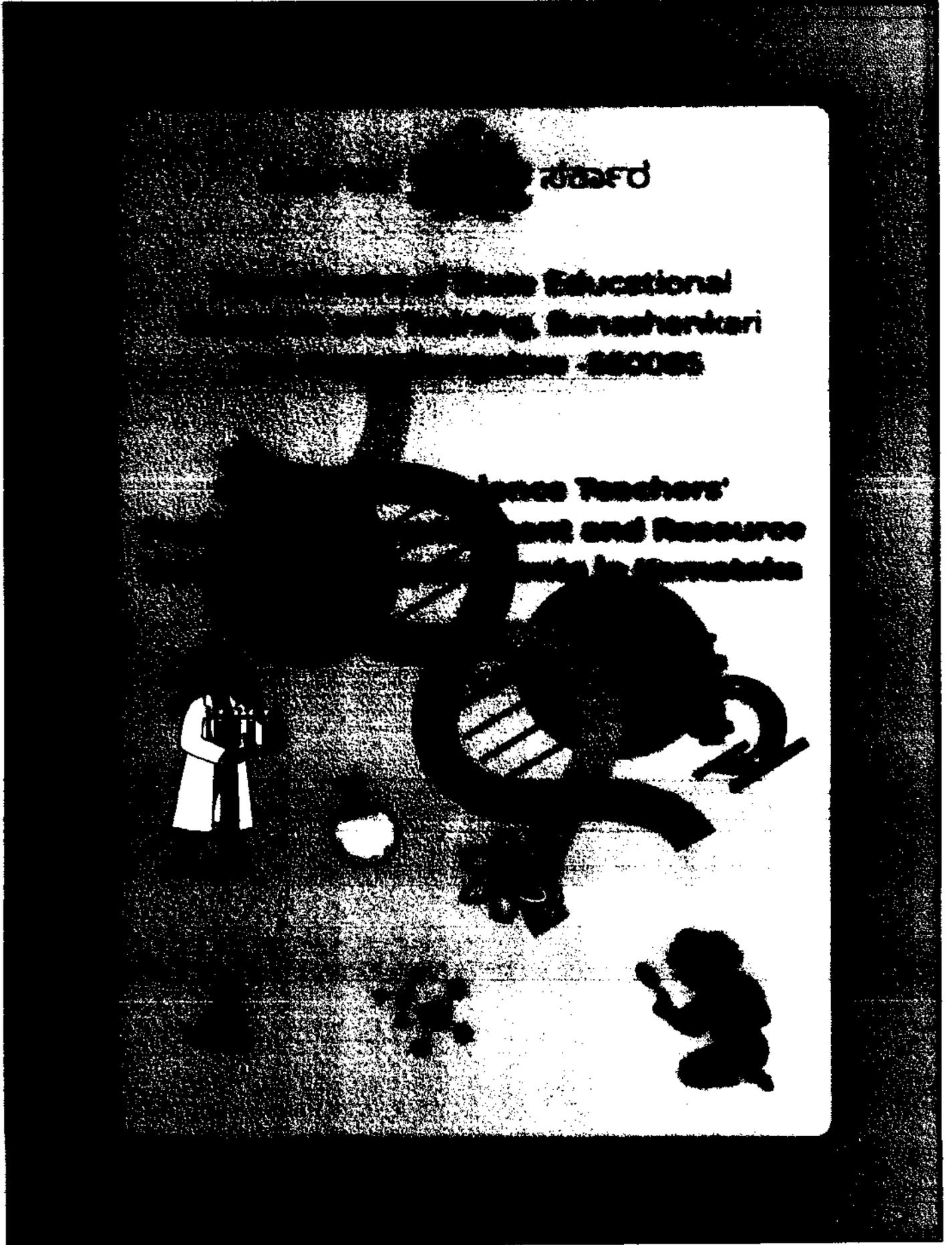
Requirements of Karnataka

Contents

Acknowledgement

Chapter - 1 INTRODUCTION AND CONCEPTUAL FRAMEWORK

1.1 Background of the Study

Science education plays a crucial role in shaping students' understanding of the world, fostering inquiry, critical thinking, and problem-solving skills. The Nature of Science (NoS) is a fundamental component of science education, influencing both teaching methodologies and student learning outcomes. Teachers' perceptions and understanding of NoS significantly impact their instructional strategies and the way scientific concepts are conveyed in the classroom.

In Karnataka, Science as a separate subject in the curriculum is introduced from the upper primary stage. Despite efforts to enhance teacher training and professional development, there is limited research on how well teachers grasp the NoS and integrate it into their pedagogy. Additionally, the availability, adequacy, and utilization of resources remain critical factors influencing the effectiveness of science teaching. Addressing these gaps can contribute to evidence-based policy recommendations and improvements in science education across the state.

Improving science education hinges on the professional development of teachers and the availability of adequate resources. This study evaluates the current state of teacher training and resource availability in Karnataka, providing a roadmap for future improvements. This research seeks to identify the specific needs of science teachers across the state, assess existing resources, pinpoint resource deficiencies, and propose concrete recommendations for enhanced training programs and resource mobilization. By understanding these aspects, this study aims to contribute to the development of a more effective and well-supported science education system in Karnataka.

1.2 Problem Statement

There is a growing need to evaluate how science teachers understand and implement the NoS in their classrooms. While various capacity-building programs and teacher training initiatives are conducted, it is unclear to what extent these initiatives translate into effective classroom practices. Furthermore, resource availability and adequacy remain a persistent challenge, particularly in under-resourced schools. Without a clear understanding of teachers' needs, challenges, and expectations, science education in Karnataka may continue to face barriers that hinder effective teaching-learning processes. This research aims to bridge these gaps by exploring teachers' perceptions, identifying training needs, assessing resource deficiencies, and providing practical recommendations for future improvements.

1.3 Research Objectives

The study aims to achieve the following objectives:
- To understand teachers' perceptions and understanding of the Nature of Science and its relevance in science teaching.
- To identify the training needs of science teachers across Karnataka.

- To evaluate the availability and adequacy of current resources for science education and identify specific resource deficiencies.
- To develop practical recommendations for future science teacher training programs.
- To propose a plan for resource mobilization to address identified deficiencies.

1.4 Research Questions

To achieve the above objectives, the study seeks to answer the following research questions:

1. What are science teachers' understanding of the Nature of Science, and how is it reflected in their science teaching?
2. To what extent are science teachers able to apply their learnings from different capacity-building training and workshops in the classroom?
3. What support do teachers expect for effective classroom transactions across different school types and locations in Karnataka?
4. What are the challenges faced by science teachers in the teaching-learning of science in the classroom?
5. What resources are currently used by science teachers, and how are they being used?
6. What are the specific resource requirements for science teachers?
7. To what extent are locally available materials/day-to-day materials being used by teachers in science classrooms?

1.5 Significance of the Study

This study will provide valuable insights into the current state of science education in Karnataka, focusing on teachers' perspectives, training needs, and resource constraints. The findings will help policymakers, educators, and stakeholders in designing effective professional development programs and improving resource allocation strategies. By addressing the identified gaps, this research aims to contribute to the overall enhancement of science teaching and learning experiences, ultimately fostering a more robust and effective science education system.

1.6 Scope and Limitations

The study will focus on science teachers in government schools across the four zones in Karnataka. Since science as a separate subject is taught from upper primary stage, the sample will include teachers teaching grades 6 to 10. It will employ surveys, interviews, and classroom observations to gather data. However, the study may be limited by factors such as sample size, geographic constraints, data collectors and variations in school infrastructure and support systems.

1.7 Organization of the Report

The report is structured as follows:

- **Chapter 1: Introduction** – Provides an overview of the research background, problem statement, objectives, research questions, significance, scope, and organization of the study.
- **Chapter 2: Literature Review** – Reviews existing literature related to the Nature of Science, teacher training, resource availability, and science education challenges.
- **Chapter 3: Research Methodology** – Details the research design, sampling strategy, data collection methods, and analysis techniques.
- **Chapter 4: Data Analysis, Findings, and Interpretations** – Presents the key findings based on data collected from science teachers across Karnataka. Interprets the results, discusses their implications, and suggests practical interventions.
- **Chapter 5: Conclusions and Recommendations** – Summarizes the study, highlights key takeaways, and proposes actionable recommendations for policymakers and educators.

By systematically addressing these aspects, the study aims to provide a comprehensive understanding of the challenges and opportunities in science education in Karnataka and inform future policy and practice.

Chapter 2 : REVIEW OF RELATED LITERATURE

2.1 The Importance of Science Teaching in Education

Science education plays a vital role in shaping students' critical thinking, problem-solving abilities, and understanding of the natural world. According to Anderson (2007), science teaching is not just about imparting facts but about developing inquiry-based learning and fostering scientific thinking. For teachers to effectively teach science, they must have a deep understanding of both the content they are teaching and the best pedagogical methods for engaging students in science learning.

Teaching in science involves not only the transmission of knowledge but also the cultivation of skills such as observation, experimentation, and logical reasoning. As teachers, their conceptual understanding of science influences how they present scientific concepts to students and how they encourage students to engage with the material (Beichner et al., 2014).

2.2 Teachers Perception about Science Teaching

The perceptions of teachers about science teaching and the nature of science (NOS) are fundamental in shaping the way science is taught in classrooms. Teachers' understanding and beliefs about science, its methodologies, and its relevance influence their pedagogical approaches, curriculum delivery, and student outcomes. This literature review explores existing research on science teachers' perceptions of science teaching and the nature of science, with a particular focus on their implications for professional development and resource mobilization in the context of Karnataka.

Hodson emphasizes that science education should not just be about learning facts, but also about understanding the nature of science itself—its processes, methods, and the way knowledge is constructed and validated. This critical aspect of science education helps students develop a scientific temper, a goal emphasized in the NCF 2005.

2.3 Implication for Teacher Professional Development:

Teachers must be equipped with an understanding of the nature of science and how to communicate this to students. In Karnataka, professional development programs should be designed to incorporate these elements and help teachers develop the confidence and expertise to teach students not only scientific content but also how science works (Vijayalakshmi, 2022).

2.4 Science Teachers' Beliefs and Attitudes

Teachers' beliefs about science teaching significantly influence their instructional decisions. Research by Pajares (1992) argues that teachers' personal beliefs about teaching and learning shape how they approach the science curriculum. These beliefs are often shaped by the teachers' own experiences as students, their training, and the institutional culture they work in.

For example, science teachers who view science as a set of fixed, unchanging facts may be less likely to encourage critical thinking or exploration in their students (Barmby et al., 2008). In contrast, teachers who view science as a dynamic, inquiry-driven process are more likely to implement teaching methods that emphasize problem-solving, experimentation, and critical analysis. These beliefs about science teaching often align with teachers' classroom practices and how they structure lessons.

In the context of Karnataka, as well as many other regions, teachers' beliefs and attitudes can be influenced by local educational policies, community expectations, and available resources (Govinda et al., 2014). For instance, in rural Karnataka, teachers may have a more traditional view of science teaching due to constraints in training and professional development.

2.5 Pedagogical Approaches in Science Teaching

The constructivist theory, which underlines that knowledge is built through experience and interaction, is often cited in the context of science teaching. Vygotsky's (1978) ideas on social learning and scaffolding suggest that teachers should provide the necessary support to guide students through their scientific inquiries. However, the degree to which teachers integrate these strategies into their teaching practices depends on their understanding of these pedagogical approaches.

Effective science teaching requires not only a strong understanding of content but also a robust pedagogical approach. Teachers must choose instructional strategies that promote active learning, such as inquiry-based learning, cooperative learning, and project-based learning (Wenning, 2011). Inquiry-based science teaching, for example, encourages students to ask questions, develop hypotheses, conduct experiments, and analyze results, helping them understand the scientific process.

Research by Yager (2014) emphasizes that inquiry-based learning and student-centered teaching approaches have been shown to improve student engagement and understanding in science classrooms. However, teachers' understanding of these approaches and their ability to implement them effectively varies significantly. Teachers often face challenges in balancing content delivery with the need to facilitate student exploration and experimentation, particularly in classrooms with large numbers of students or limited resources (Zeidler, 2014).

2.6 Resource Mobilization for Science Education in Karnataka

Resource mobilization is a critical element in improving the quality of education. As observed by Anwar and Nisa (2019), mobilizing resources—whether financial, human, or material—is essential to ensure that teachers have access to the tools, training, and support they need to teach effectively. In Karnataka, as in many other Indian states, resource mobilization for science education remains a significant issue, particularly in rural schools.

Recent studies, such as that by Prasad and Venkatesh (2021), highlight that while Karnataka has made strides in improving science education through government funding and schemes like the

Karnataka State Quality Education Programme (KSQEP), there is still a substantial gap in the availability and distribution of resources to science teachers. The gap is particularly pronounced in terms of teaching aids, laboratory facilities, and access to current scientific literature and technology.

Furthermore, resource mobilization strategies need to take into account local needs and contextual challenges. As pointed out by Joshi et al. (2022), resource mobilization should not only focus on financial resources but also on human resources such as training experts, mentors, and curriculum designers, as well as material resources like updated textbooks, laboratory equipment, and ICT infrastructure.

2.7 Challenges in Resource Mobilization in Karnataka

A significant challenge in the resource mobilization efforts in Karnataka is the uneven distribution of resources between urban and rural areas. Rural schools, especially those in remote regions, often lack basic infrastructure, such as science labs and computer facilities, which are critical for quality science education (Krishna et al., 2018). Moreover, there is a shortage of specialized science educators in these areas, which affects the quality of PD programs offered to science teachers.

In Karnataka, many teachers also face difficulties in accessing professional development opportunities due to logistical constraints, lack of funds, or absence of time during the academic year. A study by Ramesh and Sathish (2020) emphasizes that resource mobilization for PD should involve not only external funding but also active collaboration with local communities, non-governmental organizations (NGOs), and educational experts to create an ecosystem of support for science educators.

2.8 The Role of ICT in Professional Development and Resource Mobilization

The use of Information and Communication Technology (ICT) in teacher professional development has been a significant area of research in recent years. Studies by Mishra and Koehler (2006) have shown that integrating technology into PD programs can have a substantial impact on teaching quality. For science teachers in Karnataka, integrating ICT tools such as online courses, webinars, and virtual labs can provide opportunities for continuous learning and access to resources that might otherwise be unavailable.

In their study, Patel and Verma (2021) argue that the use of ICT can address the resource mobilization issue by providing low-cost access to professional development opportunities, digital textbooks, and virtual lab simulations. Despite this potential, there are challenges such as inadequate digital literacy among teachers and poor internet infrastructure, especially in rural areas, which need to be addressed for ICT to be fully effective in Karnataka.

2.9 Science Teachers' Professional Development in India

Kumar and Sharma (2018) found that while there have been numerous government initiatives and schemes aimed at enhancing the professional development of science teachers, such as the Rashtriya Madhyamik Shiksha Abhiyan (RMSA) and the National Initiative for School Heads' and Teachers' Holistic Advancement (NISHTHA), the implementation of these programs is often inconsistent across different states. Teachers in Karnataka, especially those in rural areas, often lack sufficient resources, mentorship, and opportunities for continued learning.

In India, the professional development of science teachers has received increasing attention in recent years. A study by Tiwari and Kumari (2020) explores the significant challenges faced by science teachers in rural and semi-rural areas of India, particularly in states like Karnataka. These challenges include limited access to quality training programs, inadequate exposure to new pedagogical strategies, and a lack of ongoing support after formal training sessions.

2.10 Current State of Science Teacher Training Programs in Karnataka

In Karnataka, the government and educational bodies need to create a more integrated approach to PD that includes subject-specific training, collaborative workshops, mentoring, and peer learning opportunities. Programs should also be context-sensitive and incorporate local knowledge, ensuring that teachers in different regions of Karnataka can benefit equally from these initiatives (Chandrashekar, 2019).

Recent assessments of science teacher training programs in Karnataka, such as the study by Bhavani et al. (2022), suggest that while there is a growing focus on improving teacher competencies, there is still room for improvement in the design and implementation of PD programs. The lack of a coherent framework for science teacher PD, coupled with an overemphasis on theoretical content rather than practical, hands-on experiences, has limited the effectiveness of many programs. Moreover, there is a gap in terms of personalized training that addresses the diverse needs of teachers, particularly those in rural or underprivileged areas.

CHAPTER 3: RESEARCH DESIGN

3.1 Introduction

The research titled *Evaluation of Science Teachers' Professional Development and Resource Mobilization Requirements in Karnataka* employed a mixed-method approach, integrating quantitative surveys and qualitative interviews. This approach aimed to assess teachers' understanding of the Nature of Science (NoS), its role in classroom teaching, and to provide a holistic understanding of the challenges faced by science teachers, resource availability for science teaching and hence identify the training needs of science Teachers.

The study was conducted across 17 districts in Karnataka, ensuring representation from urban and rural locations with teachers teaching in HPS and HS Levels.

3.2 Selection of Schools & Participants

The selection process ensured fair and balanced representation across diverse schools. The key participants included:

- **Science Teachers:** From Government Higher Primary and Secondary Schools across various districts
- **Headmasters (HMs):** To provide administrative perspectives on teacher development.

Schools from four districts within each of Karnataka's four divisions were chosen to ensure geographical and infrastructural diversity.

3.3 Data Collection Methods

3.3.1 Online Surveys (Quantitative Data)

A Google Form-based survey was distributed to science teachers in the selected schools, collecting information on

- Educational qualifications & teaching experience
- Participation in professional development programs & training needs
- Access to teaching resources & laboratory facilities
- Challenges in implementing effective science education

3.3.2 Interviews & Classroom Observations (Qualitative Data)

Structured interviews were conducted with Headmasters and Science Teachers to gather insights into professional development needs. Additionally, classroom observations evaluated:
- Pedagogical approaches used by teachers
- Availability and utilization of science teaching resources
- Student engagement levels during science lessons

Interviews were either voice-recorded or manually transcribed for further analysis.

3.3.3 Focus Group Discussions (FGDs)

FGDs were conducted to encourage collaborative discussions and capture diverse perspectives from the teachers of both cohorts handling grades of upper primary and secondary stages.

3.4 Data Processing & Analysis

3.4.1 Quantitative Analysis

- Survey responses were statistically analyzed to identify common trends among classroom instructions, teaching practices, resource availability, and professional development needs.
- Descriptive statistics (percentages, means) were used to compare responses across districts.

3.4.2 Qualitative Analysis

- Interview transcripts were coded to identify emerging themes related to teacher challenges, resource needs, and training gaps.
- FGDs with teacher cohorts (both upper primary and secondary teachers) provided in-depth perspectives that complemented survey data.

3.4.3 Comparative Analysis

- Classroom observations were cross-verified with teacher interviews to check consistency in responses.
- Final insights were summarized in tabular and graphical formats for better readability

3.5 Timeline & Execution

Research Flow

i. Literature Review & Tool Development

ii. Field Data Collection (Surveys, Interviews)

iii. Data Analysis & Report Preparation

iv. Report Finalization & Dissemination

All collected data was uploaded to Google Drive, categorized by:

- School Name
- Headmaster Interviews
- Teacher Interviews
- Classroom Observations

3.6 Visual Representation of the Research Process

Phase	Key Activities
Pre-Visit (Before School Visit)	Enter school data in Google Sheet, send Google Form survey to teachers, prepare & print interview questionnaires
During School Visit	Conduct interviews with HMs & teachers, observe science classrooms, take photographs for documentation
Post-Visit (After School Visit)	Upload data & reports to Google Drive, review & verify collected information, conduct final data analysis

This structured methodology ensured an accurate, reliable, and impactful evaluation of science teachers' professional development and resource needs in Karnataka. By addressing existing gaps, the study aimed to create long-term improvements in science education.

Chapter - 4 ANALYSIS, FINDINGS AND INTERPRETATION

4.1 Demographic details:

Distribution of response across Location
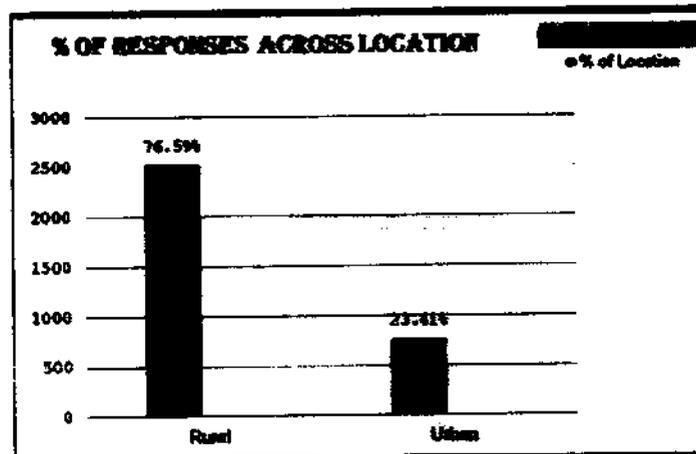
The bar chart represents the percentage of responses across different locations—Rural and Urban. Most responses (76.59%) come from rural areas. Urban areas contribute only 23.41% of the total responses. The visual representation suggests that rural respondents significantly outnumber urban respondents. This could be because the survey distribution or outreach efforts might have been more effective in rural regions or Rural population might have been more willing or available to respond.

Distribution of responses across School types:
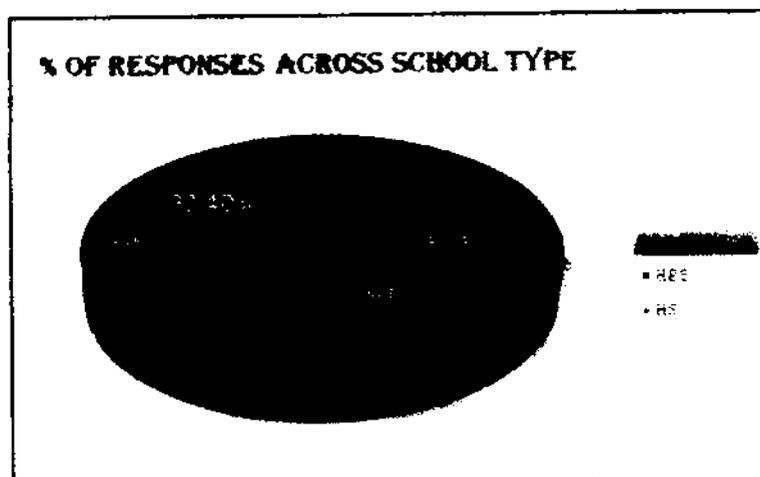
The pie chart displays the percentage of responses across different school types, labeled as HPS and HS. HPS (67.60%) has received many responses. HS (32.40%) has significantly fewer responses. There is a noticeable difference, with HPS having more than twice the number of responses compared to HS. The disparity could be due to differences in survey access, awareness, or willingness to participate between the two school types.

Percentage of CBZ and PCM teachers participated in the survey

% OF PCM AND CBZ TEACHERS IN HS

PCM   CBZ
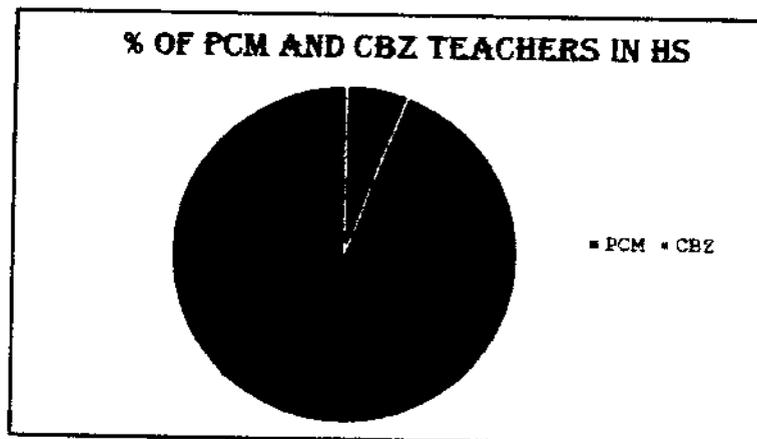
This pie chart presents the percentage distribution of PCM and CBZ teachers in HS (High School). CBZ teachers make up 94% of the total teacher population in HS. PCM teachers constitute only 6%. The number of PCM teachers is significantly lower compared to CBZ teachers. PCM teachers are a small minority, making up less than one-tenth of the total teaching staff. The large gap suggests a possible shortage of PCM (Physics, Chemistry, Mathematics) teachers in HS. It could be because less number of PCM teachers took part in the survey.

Percentage of responses as per gender

% OF RESPONSES GENDER-WISE

60.98%

39.99%

Count of Gender

0.03%

Female   Male   Other
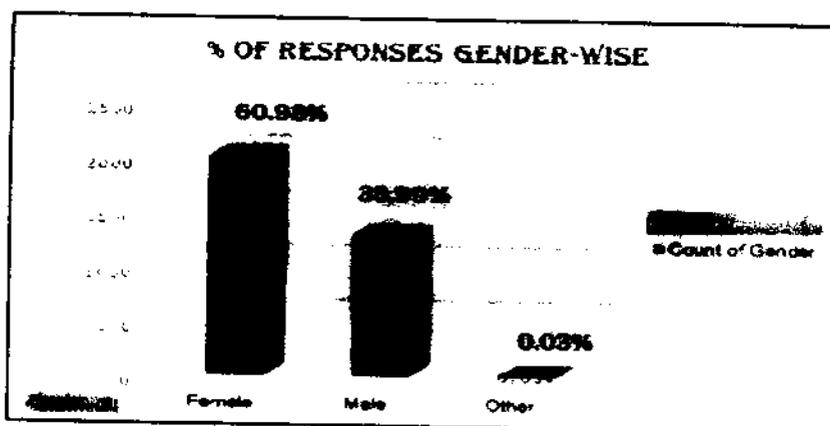
This bar chart illustrates the percentage distribution of responses based on gender. **Female respondents** form the majority at **60.98%** . **Male respondents** make up **38.99%** of the total responses. **Other gender identities** account for a very small percentage **(0.03%)**, indicating minimal representation in the dataset. There is a significant gap between female and male respondents, with females being the dominant group. The representation of non-binary or other gender identities is extremely **low**, possibly due to limited outreach, societal norms, or self-identification barriers. The **greater** percentage of female respondents may suggest that the surveyed population has more **females** or that females were more engaged in responding to the survey or female teachers chose or take up science teaching when compared to male teachers.

Distribution of Teaching experience
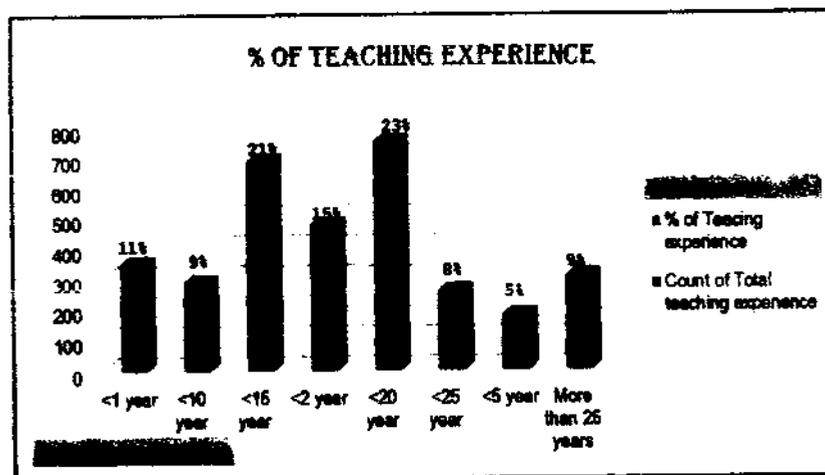
This chart represents the distribution of teaching experience across various ranges. The highest percentage (23%) of teachers fall under the **"< 20 years"** experience category. The second-highest percentage (21%) is in the **"< 15 years"** category. Teachers with **"< 2 years"** experience make up 15%, showing a significant presence of newer teachers. Lower representation is seen in the **"< 5 years"** (5%) and **"< 25 years"** (8%) groups. Only **9%** of teachers have **"More than 25 years"** of experience. This shows that most of teachers have between **15 to 20 years of experience.** There is a notable presence of early-career teachers with less than 2 years of experience (15%). The percentage of teachers with **more than 25 years of experience is relatively low (9%)**, indicating fewer senior educators. The data shows that, The teaching staff consists of a mix of experienced and relatively new teachers, which can contribute to knowledge transfer. With a significant number of teachers in the **15–20-year range**, they may soon move into leadership or senior positions. The lower percentage in the **5-year and 25+ year categories** suggest potential challenges in retaining mid-career and long-term teachers.

Educational qualification of science teachers

EDUCATIONAL QUALIFICATION
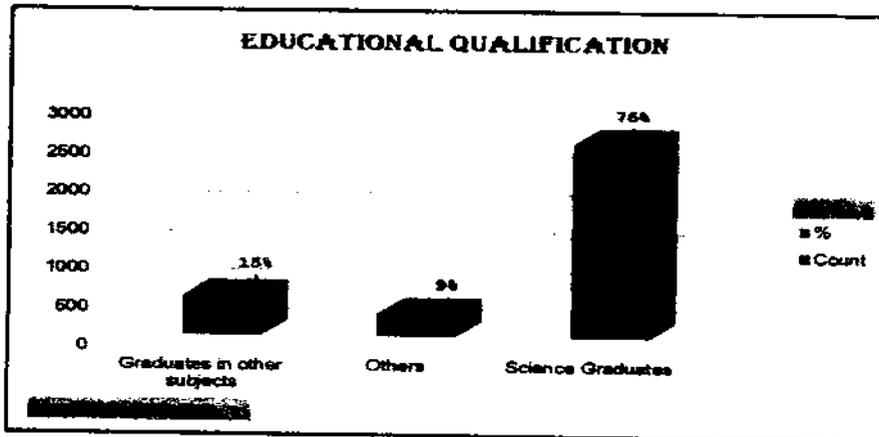
This chart represents the distribution of educational qualifications among respondents. **76% of respondents are Science Graduates**, making them the dominant group. **15% have graduated in other subjects**, indicating a smaller proportion of non-science graduates. **9% fall under the "Others" category**, which may include vocational qualifications, diplomas, or non-traditional education paths. The overwhelming majority of respondents have a **science background**. There is relatively **low representation from non-science graduates and other educational categories**. By combining the **"Graduates in Other Subjects" (15%)** and **"Others" (9%)**, we find that **24% of respondents do not have a formal science degree**. This means nearly one-fourth of the teaching workforce may not have specialized science training. **Teachers without science degrees** may struggle with **technical concepts, laboratory work, and real-world applications** of science. This could **lower the quality of science education**, especially in complex subjects like Physics and Chemistry. Schools may need **continuous professional development programs** for non-science teachers. **Collaboration between science and non-science educators** could improve content delivery. **Hiring more specialized science teachers can balance the skill gap** in the system.

Professional Qualification of respondents in the survey

PROFESSIOANL QUALIFICATION

19
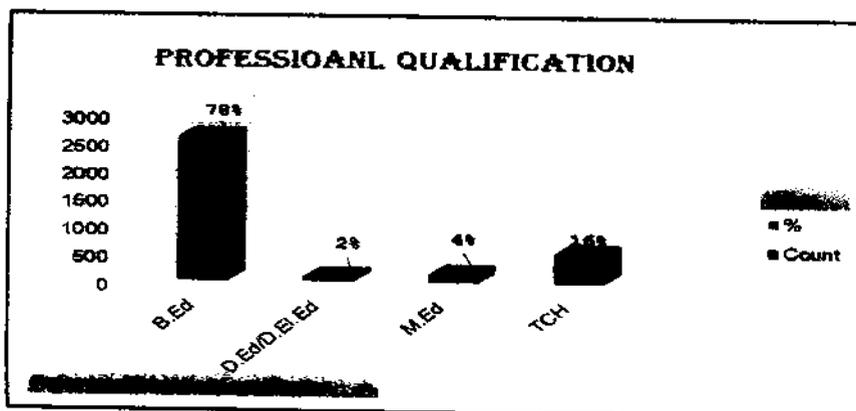
This chart presents the distribution of **professional qualifications** among respondents, highlighting the level of formal teacher training. Most respondents hold a **B.Ed. degree**, indicating that most teachers have undergone **structured training** in education. This suggests a strong foundation in **teaching methodologies, classroom management, and subject pedagogy**. Only **4% have an M.Ed. (Master of Education)**, which may indicate limited participation in advanced education research or leadership roles in teaching. A lower percentage of M.Ed. graduates could mean fewer experts in **curriculum development, educational policies, and teacher training programs. Limited Representation of D.Ed./D.El.Ed. (Diploma in Education) - 2%** These are essential for elementary-level teaching, but their low percentage suggests that **most respondents are focused on secondary education rather than primary education.** A significant portion (16%) has **basic teacher training through certification programs**, which may cover essential pedagogy but not in-depth subject expertise. **Professional development programs** for TCH and non-B.Ed. teachers can bridge skill gaps. **Targeted Training for TCH Holders in Science, workshops, online courses, and mentorship programs** can improve their **subject expertise.**

Teacher grouping by their appointed roles.
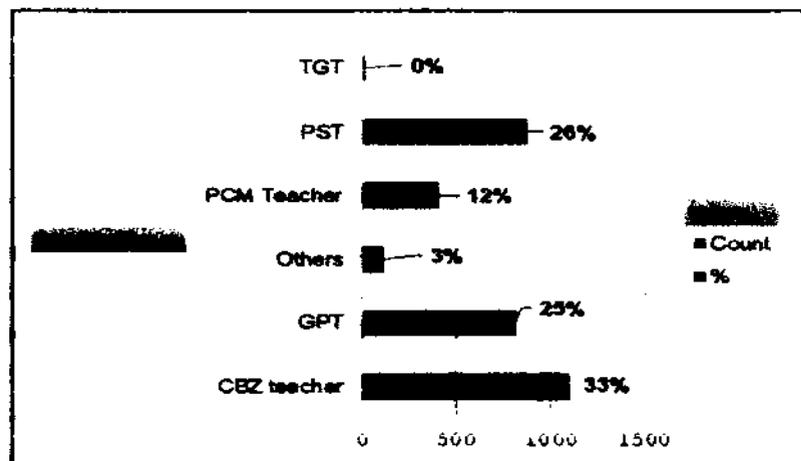
This chart highlights the **distribution of teachers by their appointed roles**. The focus on science education can be analyzed based on the proportion of PCM (**Physics, Chemistry, Mathematics) and CBZ (Chemistry, Botany, Zoology)** teachers in comparison to other roles. **CBZ Teachers Form the Largest Group (33%)** → **Strong Presence of Life Science Educators.** A **high percentage of CBZ teachers** suggests that life sciences (biology, environmental science) are well covered. **Low PCM Teacher Percentage (12%)** → **Possible Gap in Physical Science Teaching**, without a **proportional** presence of PCM teachers, students may have weaker instruction in **physics and mathematics-related sciences and** may have weak foundation in **physics, chemistry, and mathematics. Significant Number of PST & GPT Teachers (26% and 25%)** → **Generalist Teaching Dominates.** Primary School Teachers

(PST) and Graduate Primary Teachers (GPT) **form a significant portion** of the workforce. These teachers often **handle multiple subjects**, meaning science education might **not receive specialized attention** at foundational levels. **High Dependence on Generalist Teachers (PST, GPT)** might indicate less specialized science teaching at **primary and secondary levels. No Trained Graduate Teachers (TGT - 0%) → Absence of Advanced Subject Specialists.** TGTs are usually **subject experts**, particularly in higher grades. The absence of TGTs could indicate a **shortage of specialized science educators in secondary schools**, which might **impact advanced science learning.**

Teachers teaching different subjects along with science
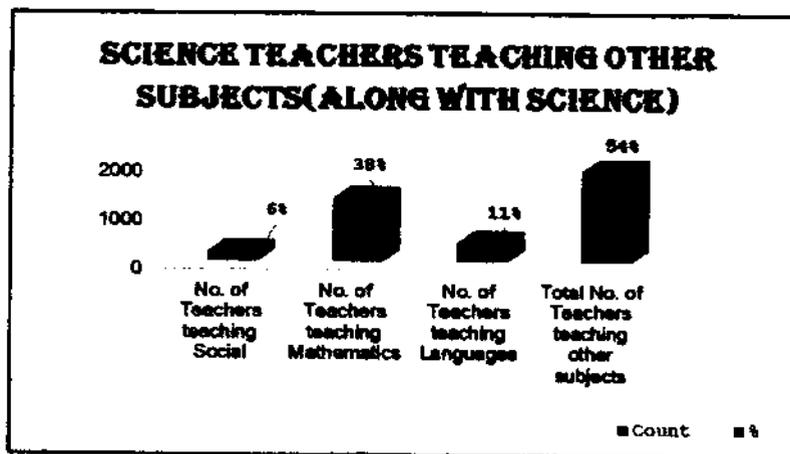
This chart shows % of teachers teaching different subjects along with science. Percentage of Science Teachers Handling Other Subjects is more than half (54%) of science teachers are assigned subjects other than science. This suggests a shortage of specialized teachers, forcing science educators to teach outside their expertise. Mathematics is the Most Common Additional Subject (38%) A significant number of science teachers also teach Mathematics. This could be beneficial as Math and Science are interrelated, but it may indicate a lack of dedicated math teachers. Science Teachers Teaching Languages (11%) & Social Studies (6%) It is concerning that science teachers are handling language and social studies—subjects vastly different from science. This may reduce the quality of teaching in both subjects due to a lack of specialized training. Because of this distribution, Science teachers may struggle to maintain high-quality science education while handling unrelated subjects. They might get less time for practical experiments, research-based teaching, and conceptual clarity in science. Also, managing multiple subjects might increase workload and stress, leading to inefficient teaching

4.2 Teachers' views, beliefs and perceptions about Science and Science teaching

Approaches to teaching science
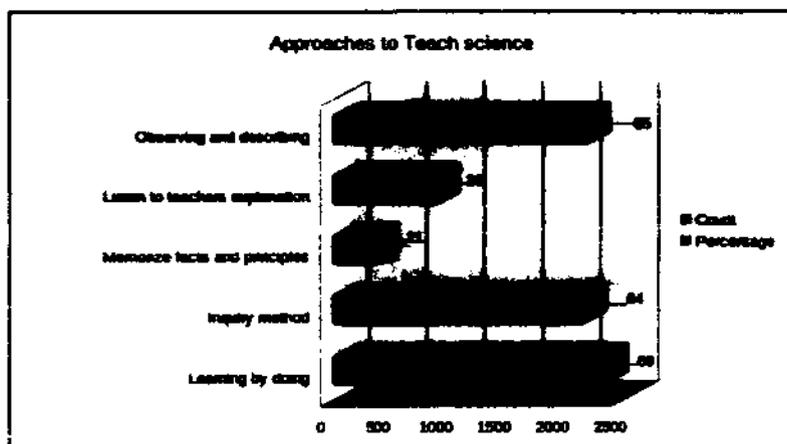
The data shows that **learning by doing (69.3%)** is the most frequently used teaching approach, with **2,283 responses**, highlighting the strong emphasis on hands-on experiences in science education. **Inquiry-based learning (63.7%)**, reported by **2,097 teachers**, is another widely used method, encouraging students to explore and ask questions to develop their understanding. **Observing and describing (64.9%)**, mentioned in **2,139 responses**, is also a popular approach, reinforcing the importance of direct engagement with scientific phenomena. Meanwhile, **listening to teacher explanations (26.4%)**, with **869 responses**, is still used but significantly less common than interactive approaches. **Memorizing facts and principles (11.0%)** received the lowest responses (361), suggesting that rote learning is becoming less relevant in science classrooms.

The strong focus on hands-on and inquiry-driven learning suggests that **science education is increasingly adopting a constructivist approach**, where students actively build knowledge through exploration and experimentation. The low emphasis on **memorization reflects a move away from traditional rote learning** toward a more application-based understanding of scientific concepts. However, the fact that some **teachers still rely on explanations (26.4%)** suggests that direct instruction has not been completely replaced, likely because it provides foundational knowledge necessary for deeper inquiry.

While the data highlights a positive trend toward active learning, **balancing different teaching strategies remains important**. While hands-on activities and inquiry-based learning are crucial for engagement and critical thinking, **a structured approach that combines direct teaching, guided inquiry, and practical applications** may be most effective. Ensuring that students have foundational knowledge before engaging in explorations can help maximize learning outcomes.

Teaching approach: Encourage to score good marks in science
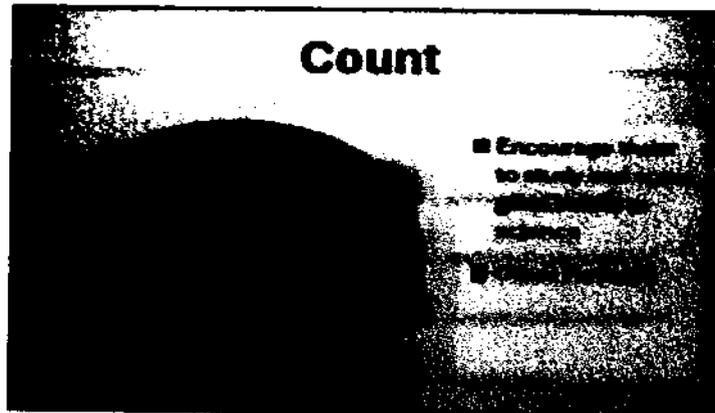
- Only **23%** of teachers prioritize academic performance (marks) as the primary motivation strategy.
- A vast majority—**77%**—report using other approaches, which could include fostering curiosity, hands-on activities, real-world connections, or promoting conceptual understanding.

This suggests that most teachers view science education as more than just scoring marks, indicating a possible shift toward student-centered and inquiry-based learning rather than exam-centric teaching.

Teacher beliefs about science teaching
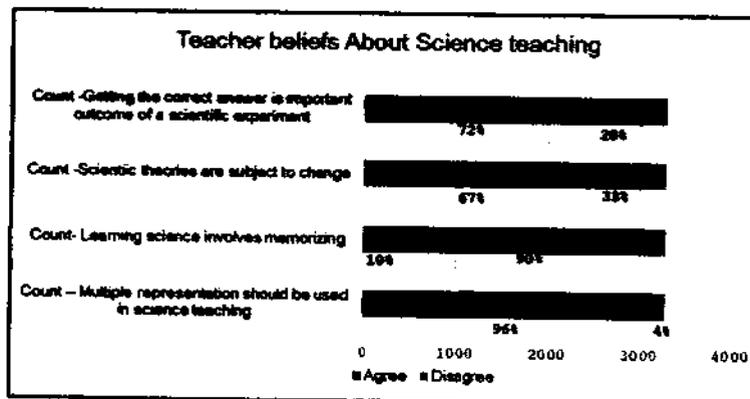
Most teachers support modern approaches to science education. **95.84% agree** that using **multiple representations** such as diagrams and models enhances science teaching, while only **4.16% disagree**. Similarly, **90.25% of teachers disagree** that **learning science involves memorization**, indicating a strong preference for conceptual understanding over rote learning. However, there is some variation in beliefs about the nature of scientific knowledge—while

67.02% acknowledge that scientific theories evolve, 32.98% still believe that scientific knowledge is fixed. Additionally, 71.58% of teachers agree that getting the correct answer is an important outcome of a scientific experiment, whereas 28.42% disagree, suggesting that a significant number of teachers still prioritize accuracy over the investigative process.

The data suggests that most teachers support modern, student-centered approaches to science education. The overwhelming agreement (95.84%) on using multiple representations indicates that educators recognize the importance of diverse instructional methods to enhance student comprehension. The high disagreement (90.25%) with the idea that science is about memorization further confirms that teachers are shifting towards fostering deeper conceptual understanding rather than focusing on factual recall.

However, there is some division in beliefs about the nature of scientific knowledge. While 67.02% acknowledge that scientific theories evolve, a significant 32.98% still believe that scientific knowledge is fixed, which could impact how they present scientific discoveries in the classroom. Additionally, the strong emphasis (71.58%) on obtaining correct answers in experiments suggests that many teachers still value precision in science learning, which might overshadow the importance of inquiry, critical thinking, and the process of experimentation.

However, the perception of scientific theories as fixed and the focus on getting correct answers highlight areas for further development. Encouraging teachers to view science as an evolving discipline and to prioritize the scientific process over just correct results could enhance critical thinking and innovation in students. Professional development programs and raining can help bridge these gaps, ensuring that teachers fully embrace scientific inquiry and the dynamic nature of science in their teaching practices.

Teacher belief- Scientific theories are subject to change
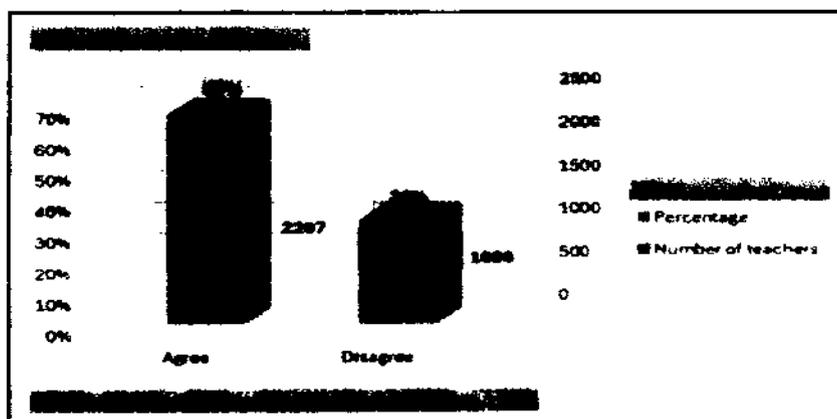
Key Observations:

- **67%** of teachers agree that scientific theories are not fixed and can change over time based on new evidence or better understanding.
- However, a significant portion (**33%**) of teachers disagree with this core scientific principle, indicating a possible misconception about the nature of scientific knowledge.
- This belief is crucial because it reflects a teacher's understanding of science as a dynamic, evolving discipline rather than a static body of facts.
- While the majority demonstrate a correct understanding of how science progresses, the one-third who disagree may inadvertently promote rigid views of scientific knowledge in the classroom.

Teacher Belief- Getting the correct answer is the most important outcome of a scientific experiment
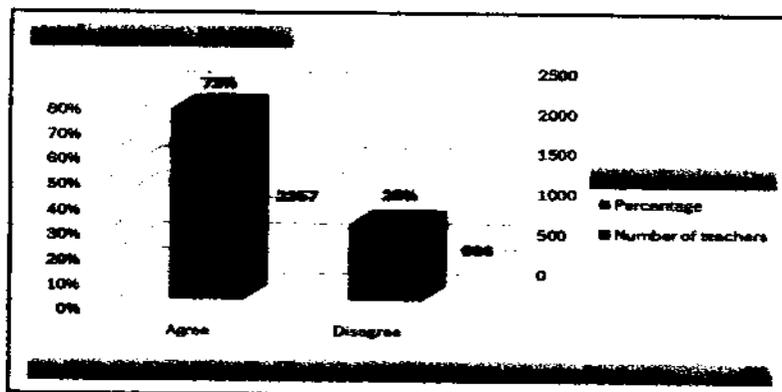
Key Observations:

A significant majority (**72%**) of the teachers surveyed agree that obtaining the correct answer is the most important outcome of a scientific experiment.

- Only **28%** of the respondents disagree with this statement, suggesting they may value other aspects of scientific inquiry, such as the process, observation, or critical thinking.
- The data highlights a strong belief in outcome-oriented approaches among teachers, which may influence how science is taught in classrooms — potentially with a focus on accuracy and results over exploration and inquiry.

Implications: This belief could reflect a traditional view of science education, where emphasis is placed on right answers rather than the experimental process, which may limit opportunities for students to explore, make mistakes, and learn through discovery. Professional development programs may consider addressing this belief, encouraging teachers to see the value of scientific thinking, curiosity, and the learning process as central outcomes of experimentation — not just correctness.

Teacher belief: Scientific theories change Vs Getting the correct answer is the most important outcome of a science experiment
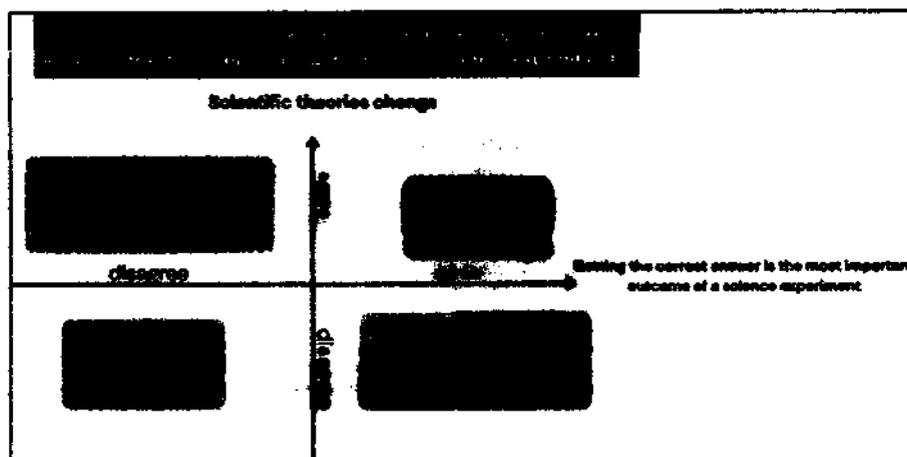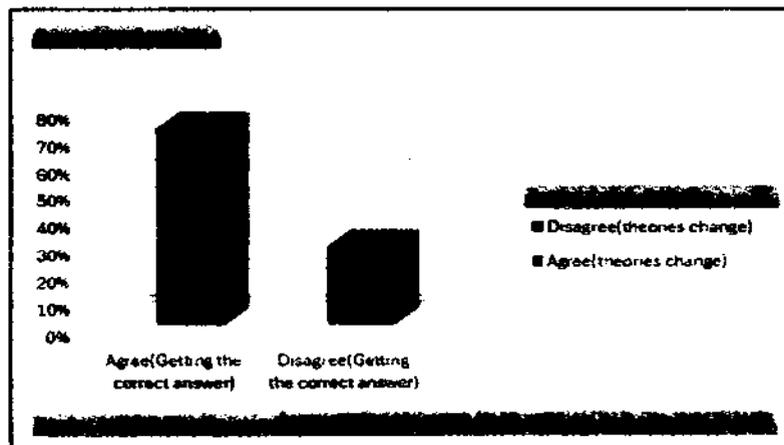
- **48%** of all teachers agree with both beliefs: they believe scientific theories can change and that getting the correct answer is most important.
- This suggests a contradiction — accepting that science is dynamic but still treating experiments as fact-confirming rather than exploratory.

Progressive viewpoint:

- **19%** of teachers disagree that getting the correct answer is most important and agree that theories change.
- This group reflects a more inquiry-based view of science, where experimentation is about exploring and revising ideas.

Traditional viewpoint:

- **24%** believe correct answers are most important and do not agree that theories change — a rigid, fact-oriented perspective on science.

Minimal but notable disconnect:

- **9%** of teachers disagree with both beliefs — possibly indicating confusion or a lack of deep engagement with the nature of science.

Interpretation:

- The largest group of teachers **(48%)** hold both progressive and traditional beliefs simultaneously, which highlights a misalignment in understanding the nature of science.
- Only about 1 in 5 teachers **(19%)** show a coherent, inquiry-aligned stance that supports scientific thinking as evolving and process-focused

Teachers' conflicting views on Science education

Here are some key insights from the chart on conflicting views in science education among teachers:
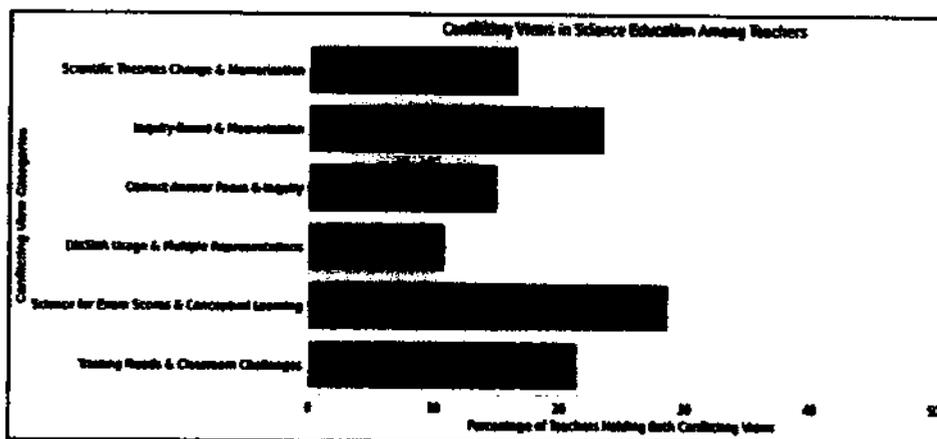
- **"Science for Exam Scores & Conceptual Learning" is the most prevalent conflict** – The highest percentage of teachers (around 30%) hold both views that science should be learned for exam scores while also emphasizing conceptual learning. This highlights a tension between rote learning for assessments and deeper understanding.
- **"Training Needs & Classroom Challenges" is another major conflict** – A significant percentage of teachers (around 20-25%) struggle with balancing their training needs and the challenges they face in the classroom. This suggests a gap in teacher preparation and real-world classroom implementation.

- **"Inquiry-Based & Memorization" conflict is common** – Many teachers hold both the belief in inquiry-based learning while still relying on memorization. This indicates an ongoing struggle in moving from traditional teaching methods to student-driven inquiry.

- **Less prevalent conflicts include "Correct Answer Focus & Inquiry" and "DIKSHA Usage & Multiple Representations"** – These conflicts are present but affect a smaller percentage of teachers, implying that they may be more specific to certain pedagogical approaches or resources.

- **"Scientific Theories Change & Memorization" is the least conflicting category** – The smallest percentage of teachers (under 10%) struggle with balancing the idea that scientific theories evolve while also promoting memorization. This suggests that fewer teachers face difficulty reconciling these views.

Comparison by School Type (HPS vs. HS)
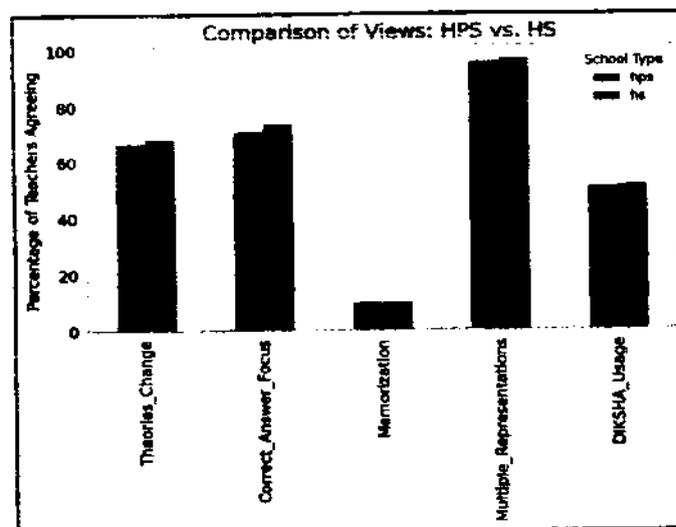
- **Theories Change**:
  - Agreement is high in both HPS (approx. 75%) and HS (approx. 70%).
  - Suggests a strong understanding across both types that scientific theories can change.
- **Correct Answer Focus**:
  - Slightly higher agreement in HS (approx. 85%) compared to HPS (approx. 80%).
  - Indicates both types of schools show a strong tendency toward emphasizing correct answers.
- **Memorization**:
  - Very low agreement in both, with HPS slightly lower (~5%) than HS (~10%).
  - Suggests that memorization is not strongly endorsed in either school type.
- **Multiple Representations**:
  - Very high agreement in both (~95%), nearly identical.
  - Indicates strong endorsement of using multiple representations in teaching.

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- **DIKSHA Usage**:
  - Similar levels of agreement (~55% in HS, ~50% in HPS).
  - Moderate but not overwhelming use or value placed on the DIKSHA platform.

Comparison by School Location (Rural vs. Urban)
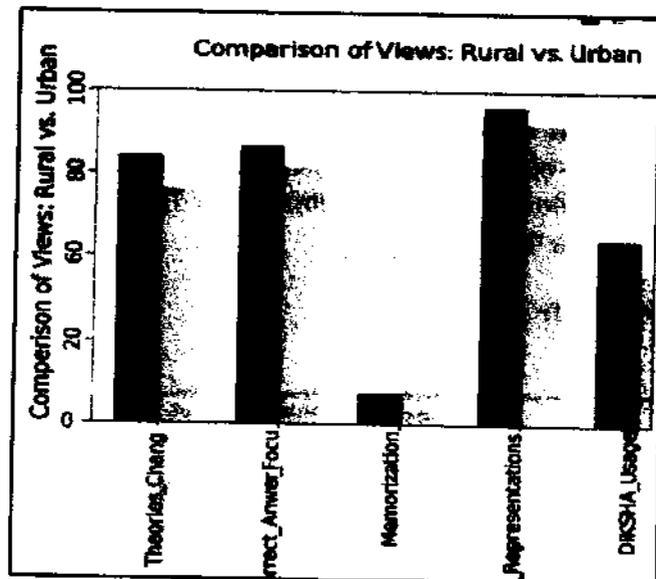
- **Theories Change**:
  - Rural teachers (~75%) show slightly more agreement than urban teachers (~68%).
  - Reflects slightly more openness to the evolving nature of science among rural teachers.
- **Correct Answer Focus**:
  - Rural (~85%) teachers agree more strongly than urban (~78%).
  - Rural schools may emphasize correctness more than urban ones.
- **Memorization**:
  - Very low agreement in both; urban (~10%) slightly higher than rural (~5%).
  - Memorization is largely not preferred across locations.
- **Multiple Representations**:
  - Both groups show very high agreement, with rural slightly higher (~98%) than urban (~95%).
  - Strong consensus across locations on the importance of varied representations.
- **DIKSHA Usage**:
  - Rural teachers (~60%) report slightly more usage than urban (~55%).
  - Slightly more reliance on DIKSHA in rural areas, possibly due to resource constraints.

Key findings from Teacher Interview data about Understanding of science and science teaching

The one-on-one interview with teachers about their understanding of science, its aims and objectives and methods of teaching science highlights the below findings, analysis and interpretation.

Focus on Scientific Attitude and Critical Thinking

The highest number of responses (83 out of 131) emphasize the importance of cultivating a scientific attitude, which involves fostering curiosity, logic, and skepticism to challenge assumptions. This highlights the priority given to nurturing critical thinking skills in students, encouraging them to question and analyze information.

Hands-On Learning is Key:

46 out of 131 responses focused on hands-on learning, practical activities, and real-world connections, it is clear that experiential learning is considered a central aspect of science education. Engaging students through experiments and interactive learning allows them to connect theory with practice, making science more tangible and meaningful.

Role of the Teacher as a Facilitator:

While only 8 out of 131 responses mention the teacher as a facilitator who guides students' exploration and independent thinking, this indicates that the student-centered approach, where the teacher acts as a guide rather than a mere knowledge provider, is still not widely implemented or emphasized.

Skills Development is Not a Major Focus:

Only 12 out of 131 responses focus on developing creativity, problem-solving, and collaboration skills. This suggests that while skills development is recognized, it is not yet a dominant focus in science education, and further emphasis could be placed on equipping students with essential Science process skill.

Limited Focus on Ethical and Holistic Development:

The responses related to ethical and holistic development (8 out of 131) indicate that honesty, discipline, and environmental awareness are somewhat less emphasized. There is a need for stronger integration of ethical values and social responsibility in science curricula, especially in addressing global challenges like sustainability.

Connection of Theory to Practice:

Connecting scientific concepts to daily life, challenging superstitions, and integrating technology received only 12 out of 131 responses. This suggests that while some educators recognize the importance of making science relevant to students' lives, there may still be room to strengthen the link between theoretical learning and practical applications.

Fostering Curiosity and Interest :

The highest frequency of responses is for Fostering Curiosity and Interest (92 out of 131), indicating that a large majority of respondents prioritize making science engaging and sparking wonder in students. This shows a strong emphasis on creating interest and excitement about science.The overwhelming emphasis on curiosity and engagement reflects the importance of creating an environment where students find science fun and intriguing. Teachers likely prioritize interactive teaching methods, such as experiments, discussions, and real-world applications, to foster an emotional connection to the subject matter.

Developing Inquiry Skills:

With 27 out of 131 responses, Developing Inquiry Skills is emphasized but less strongly than other factors. The focus here is on encouraging questioning, experimentation, and logical thinking, which are key components of the scientific method. The lower frequency could imply that inquiry-based learning is a goal that might not be as systematically integrated into all classrooms. Despite its importance, some teachers might face practical challenges in fostering true inquiry-based learning, such as time constraints, resources, or the traditional structure of science curricula.

Innovation and Creativity:

Innovation and Creativity scored 0 responses, suggesting that, according to the respondents, there is little or no emphasis on fostering innovation or creativity in the science classroom. This is a surprising result, as creativity is often considered a key driver of scientific advancement.The absence of responses here could indicate a lack of emphasis on encouraging innovative thinking in science education. This might point to a need to rethink how creativity can be integrated into science teaching. For instance, fostering an environment where students not only apply existing scientific knowledge but also learn to innovate and create new solutions could be an area for future development.

Removing Misconceptions and Superstitious Beliefs :

Finally, Removing Misconceptions and Superstitious Beliefs garnered 12 out of 131 responses. While this is important, the relatively low score may suggest that misconceptions and superstitions are not always actively addressed in the science classroom, even though they can hinder the development of a scientifically accurate worldview. Addressing and

correcting misconceptions is crucial to ensuring that students build a solid foundation in scientific knowledge. This response suggests that some teachers might be less proactive in explicitly identifying and addressing misconceptions or that it is seen as less of a priority compared to other aspects like fostering curiosity and inquiry skills.

Key findings from Focus Group Discussion on Science Teachers' Views and Understanding of Science Education

7 teachers who teach science in Higher Primary grades and 6 teachers who teach science in High School sections participated in a group discussion. A set of pointers has been used to facilitate discussion. Summary of their responses has been categorized and captured below. A major chunk of the discussion was around the challenges they face. However, their views, in particular, about science and the influence of their views on their classroom instruction are of particular interest.

Understanding Science

Most teachers defined science as a systematic method of learning about the world through step-by-step procedures. They emphasized its role in understanding everyday phenomena, such as cooking, plant growth, and rainbow formation. Teachers generally acknowledged that scientific inquiry begins with a question and is supported by evidence. However, some teachers expressed the belief that science can find answers to all questions and provide absolute proof for everything. This view suggests a limited understanding of the nature of science, particularly regarding the tentative nature of scientific knowledge.

While some teachers understood that scientific laws and theories hold equal significance, they struggled to recognize that all scientific knowledge remains subject to change. Many viewed scientific proof as absolute, akin to mathematical proof. This perspective overlooks the self-correcting nature of science, where knowledge evolves over time through further investigation and discoveries. This misunderstanding is often exploited by those who challenge scientific principles, as seen in historical examples like the misinterpretation of fossil evidence.

Science is Always Changing

Most teachers agreed that scientific knowledge is dynamic and constantly evolving due to new discoveries. Examples cited included Pluto's reclassification from a planet, the development of the atomic model, and the recognition of insectivorous plants. These examples illustrated their understanding that science is not fixed but rather an ever-improving body of knowledge.

However, a few teachers held the misconception that scientific knowledge, once tested and proven, remains unchangeable. For instance, some asserted that the principle of gravitation, which explains the motion of falling bodies, would never change. This belief reflects a misunderstanding of the nature of scientific knowledge, where fundamental concepts remain

stable, but our understanding and interpretations can evolve. Some teachers recognized that while certain foundational concepts, such as the atomic structure, remain constant, the understanding of subatomic particles continues to develop.

Understanding that science is an ongoing process rather than a collection of absolute truths is crucial in shaping positive attitudes toward scientific progress. When science is perceived as an evolving field rather than a set of fixed facts, individuals are more likely to appreciate its strengths and recognize the tentativeness of knowledge as an asset rather than a flaw.

Why We Teach Science in Schools

Teachers highlighted that science education should help students connect classroom learning to real-life situations. Science is omnipresent, from food preparation to understanding wildlife behavior. Teachers emphasized that science teaching should dispel superstitions and foster scientific thinking. They acknowledged that science is more than just memorizing facts; it should also raise awareness of the impact of development on the environment, such as the effects of urbanization on agriculture.

Science education nurtures critical thinking by encouraging students to ask "why" and "how" about the world. It develops essential skills like questioning, reasoning, and problem-solving. While teachers introduced key concepts like scientific temper, attitude, and inquiry, many were unaware of the *National Curriculum Framework* position paper on science education. This lack of awareness suggests potential gaps in fully understanding the purpose of science teaching. Strengthening this awareness could enhance the effectiveness of science education and ensure that its core principles are effectively integrated into teaching practices.

How Science Teaching Has Changed

Teachers acknowledged a shift in science teaching methods over time. Previously, science instruction relied heavily on textbooks. Today, modern teaching strategies incorporate STEM labs, hands-on experiments, and technology to encourage deeper engagement beyond textbook learning. These advancements have made science more interesting and relevant to students' futures.

However, teachers also emphasized the need for adequate resources and regular maintenance to support effective science teaching. Access to well-equipped laboratories and updated teaching materials is crucial for implementing innovative teaching methods and ensuring that students receive a comprehensive science education.

Conclusion

Understanding the nature of science is essential for evaluating its strengths, limitations, and the value of different types of scientific knowledge. While science teachers may have a strong grasp of concepts such as the atomic model, Boyle's law, and evolutionary theory, their understanding of fundamental scientific principles, such as the distinction between laws, theories, and models, varies significantly.

Research literature supports the idea that a teacher's perception of science profoundly influences their teaching approach. Nunan (1977) emphasized that a teacher's understanding of science shapes content delivery and methodology. Ogunniyi (1983) warned that inadequate conceptions of science could distort instructional outcomes. Robinson (1969) asserted that a teacher's beliefs about science directly impact their classroom behavior, while Scheffler (1973) noted that a teacher's philosophical perspective inevitably influences their teaching practices.

The findings suggest that while teachers generally recognize the evolving nature of science, some misconceptions persist. Addressing these gaps through professional development programs and curriculum awareness initiatives could strengthen science education and enhance students' scientific literacy

4.3 Resource availability and usage for teaching science

Resource availability for science teaching
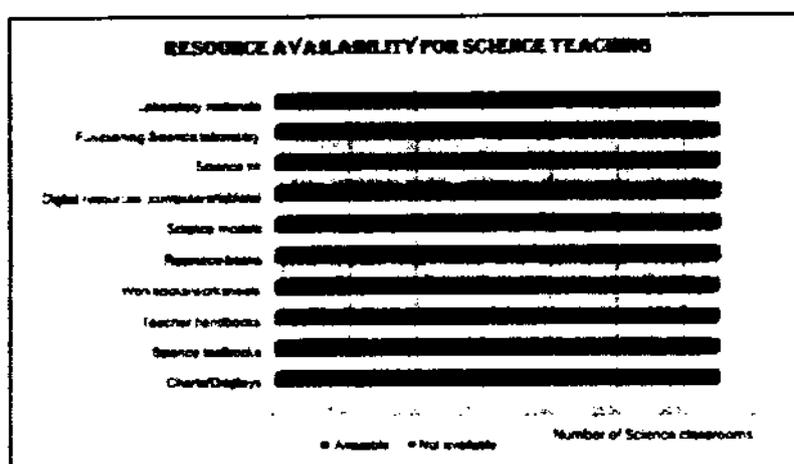
The availability of science textbooks is the highest among all resources, with **96.42%** of schools having access to them, ensuring strong curriculum support. Charts and displays (**73.10%**), science models (**72.22%**), and science kits (**67.58%**) are relatively well-distributed, indicating moderate access to visual and practical learning tools. However, teacher handbooks (**61.48%**), workbooks (**60.05%**), and laboratory materials (**60.26%**) show a gap, as around **40%** of schools

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lack these essential teaching and learning aids. Digital resources such as computers and tablets are available in only **49.48%** of schools, pointing to a digital divide. Resource books are even less available, with just **45.42%** of schools having them, limiting access to supplementary learning materials. The most concerning finding is the availability of functioning science laboratories, which stands at only **28.38%**, meaning over **70%** of schools lack proper lab facilities for hands-on experiments. This indicates a significant gap in infrastructure, affecting the quality of science education.

The data reveals a significant disparity in the availability of essential teaching and learning resources across schools. While science textbooks are widely available (**96.42%**), ensuring that students have access to core curriculum materials, other critical resources show gaps. Visual aids such as charts, science models, and science kits have moderate availability (**67%–73%**), indicating that while many schools have access to them, a considerable percentage still lacks these resources. The situation worsens with teacher handbooks (**61.48%**) and workbooks (**60.05%**), suggesting that a significant number of teachers may not have adequate reference materials for effective instruction. The availability of laboratory materials (**60.26%**) is concerning, as hands-on experiments are crucial for science education. More notably, digital resources such as computers and tablets are available in only **49.48%** of schools, highlighting a digital divide that could limit students' exposure to modern learning tools. The lack of resource books (**45.42%**) suggests a restricted access to supplementary reading materials, which could impact deeper learning and research opportunities. Most alarmingly, functioning science laboratories are available in only **28.38%** of schools, meaning that over **70%** of students lack access to essential practical science facilities, which are crucial for developing scientific skills and inquiry-based learning.

The findings suggest that while basic curriculum materials such as textbooks are prioritized, there is a lack of comprehensive resource distribution to support interactive and practical learning. The moderate presence of charts, science models, and kits indicates some effort toward enhancing science education through visual and hands-on tools, but their limited availability in many schools highlights an area that needs improvement. The low availability of digital resources suggests that many schools are not yet fully integrated with technology, which could impact students' ability to develop digital literacy and access online learning opportunities. The scarcity of resource books further limits students' ability to conduct independent research and extend their knowledge beyond textbooks. The most critical concern is the lack of functioning science laboratories, which significantly hampers experiential learning and could weaken students' understanding of scientific concepts. Without proper lab facilities, students may struggle to develop practical skills, which are essential for higher education and careers in science and technology. Addressing these resource gaps is crucial to improving the quality of science education and ensuring equitable learning opportunities for all students.

Usage of Charts and Displays
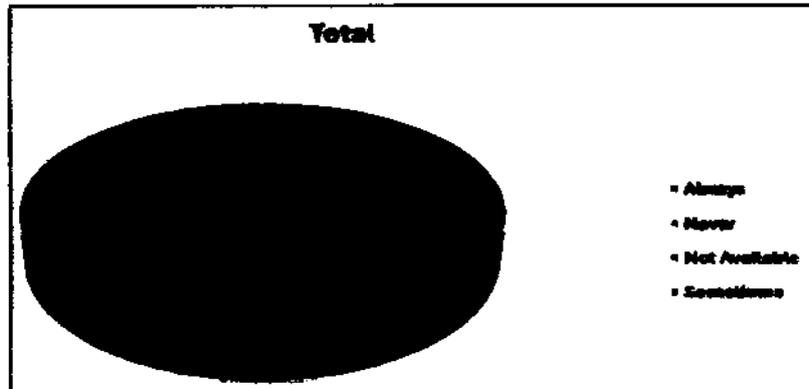
Key Findings:

Regular Usage:

- **45.92%** of teachers reported that they always use charts and displays in their science lessons.
- This indicates a strong inclination towards visual learning aids among nearly half of the teaching staff.

Occasional Usage:

- **43.88%** of teachers use charts and displays sometimes.
- This group likely integrates these tools when resources are available or based on the topic being taught

Non-Usage:

- Only **1.82%** of teachers never use visual aids.
- This is a minimal proportion, suggesting that very few are not engaging with such tools, possibly due to lack of training or awareness.

Resource Unavailability:

- **8.38%** of responses indicated charts/displays are not available.
- This highlights a potential resource gap in certain schools which needs to be addressed to enhance the effectiveness of science instruction.

Insights & Recommendations:

- The high combined percentage (89.8%) of teachers who always or sometimes use charts shows a clear preference for visual aids in science education.
- However, the **8.38%** citing unavailability of materials should prompt educational authorities to invest in creating and distributing quality visual teaching aids.
- Training programs can also be introduced to further encourage the consistent and effective use of such tools among the "sometimes" users.

Usage of Diksha App
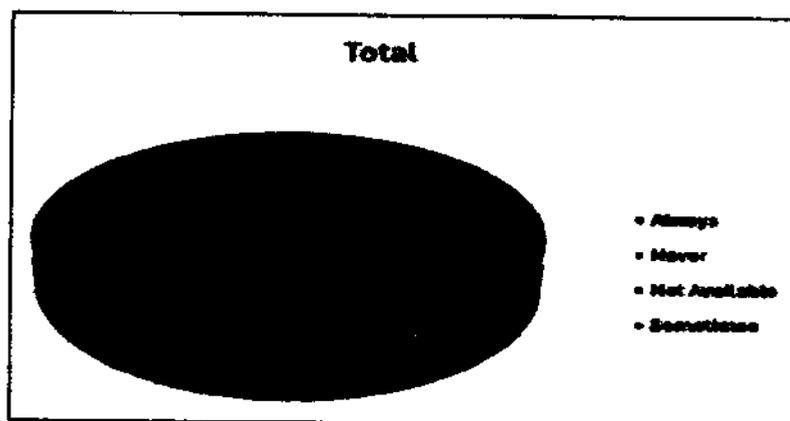
Key Findings:

Frequent Usage:

- **23%** of teachers reported they always use the DIKSHA app.
- This indicates a significant portion of educators are consistently integrating digital content into their teaching.

Occasional Usage:

The majority, **56%**, use the app sometimes.

- These users might depend on availability of internet access, familiarity with digital tools, or relevance of the content.

No Usage:

- **7%** of teachers stated they never use the DIKSHA app.
- This may be due to a lack of digital literacy, resistance to change, or content-related limitations.

Access Issues:

- 14% reported that the app or its resources are not available to them.
- This represents a technological gap that needs to be addressed, either in terms of infrastructure or digital access in schools.

Insights & Recommendations:

- The fact that 79% of teachers are either frequent or occasional users shows encouraging adoption of digital tools in classrooms.
- The 14% citing unavailability is a notable concern—targeted interventions such as device provisioning, internet support, and training can bridge this gap.
- Orientation programs and regular workshops can help shift more users from "sometimes" to "always," enhancing teaching outcomes.

Teacher belief: Usage of charts and displays V/S multiple representations in science teaching
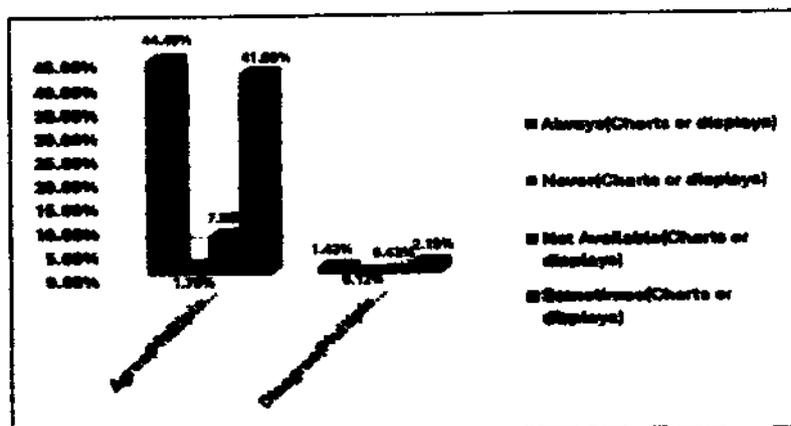
Teachers Who Agree with Using Multiple Representations (95.84% of total):

- Always use charts/displays: 44.49%
- Sometimes use charts/displays: 41.69%
- Never use charts/displays: 1.70%
- Not available: 7.96%

Insight: A large majority of teachers who agree with using multiple representations also actively integrate charts/displays, with over 86% either always or sometimes using them.

Teachers Who Disagree with Using Multiple Representations (4.16% of total):

- Always use charts/displays: 1.43%
- Sometimes use charts/displays: 2.19%
- Never use charts/displays: 0.12%
- Not available: 0.43%

Insight: Usage among this group is minimal, reflecting a lack of alignment between belief and classroom practice.

Conclusions & Recommendations:

- There is a strong positive correlation between belief in the value of multiple representations and the actual use of charts and displays.
- Educator mindset plays a key role in instructional strategies. Promoting understanding of pedagogical benefits can increase effective use of visual aids.
- The 7.96% who cite unavailability despite agreeing on its importance reflect an infrastructure gap—targeted provisioning of teaching materials may bridge this.
- Professional development programs should focus on showcasing practical benefits of multiple representations to those who remain unconvinced.

Teacher belief: Usage of science models V/S multiple representations should be used in science teaching
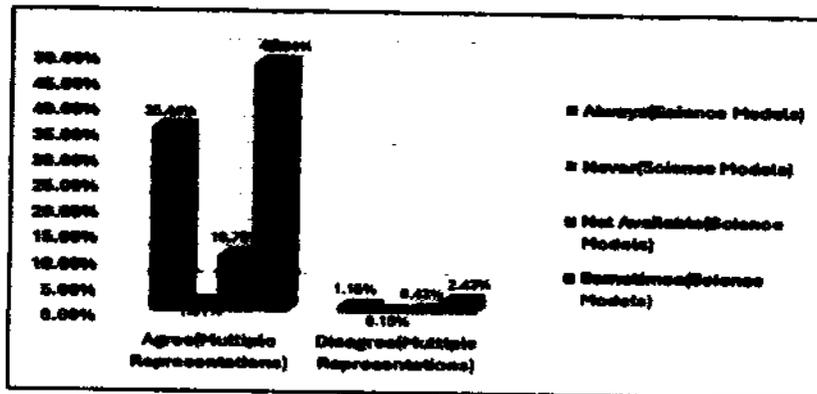
Key Insights

Teachers Who Agree with Using Multiple Representations (95.84% of total):

- Always use science models: 35.44%
- Sometimes use them: 48.04%
- Never use them: 1.61%
- Not available: 10.75%

Interpretation:

A large majority (83.48%) of teachers who support multiple representations actively use science models either *always* or *sometimes*, reflecting a strong alignment between belief and practice. However, the 10.75% citing unavailability highlights a potential resource gap.

Teachers Who Disagree with Using Multiple Representations (4.16% of total):

- Always use science models: 1.15%
- Sometimes use them: 2.43%
- Never use them: 0.15%
- Not available: 0.43%

Interpretation:

Very few teachers who do not believe in multiple representations are using models frequently. Their minimal usage is consistent with their belief, but it also suggests a missed opportunity to engage students through hands-on learning strategies.

Teacher belief: Usage of digital resources V/S multiple representations should be used in science teaching
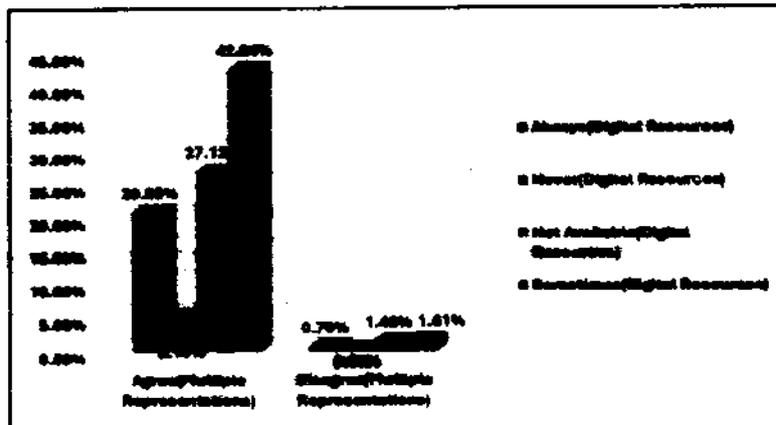
Teachers Who Agree with Using Multiple Representations (95.84% of total):

- Always use digital resources: 20.89%
- Sometimes use them: 42.64%
- Never use them: 5.1%
- Not available: 27.12%

Interpretation:

A significant 63.53% of teachers who support multiple representations are using digital resources *regularly*. However, 27.12% report lack of availability, which is the highest barrier observed among all types of resources analyzed. This suggests a critical digital divide in resource accessibility.

Teachers Who Disagree with Using Multiple Representations (4.16% of total):

- Always use digital resources: 0.7%
- Sometimes use them: 1.61%
- Never use them: 0.39%
- Not available: 1.46%

Interpretation:

Usage is low among this group, reflecting their belief, though more than half (2.31%) still use digital resources occasionally or frequently, which may indicate institutional or curriculum-based usage rather than belief-driven practice.

Conclusions & Recommendations

- There is moderate alignment between belief in multiple representations and the actual use of digital tools.
- The most pressing challenge is the high level of unavailability (27.12%), suggesting a need for:
    - Investment in digital infrastructure
    - Equitable distribution of devices
    - Professional development to build confidence in using tech for science teaching.
- Enhancing digital access could help bridge the gap between pedagogical intent and classroom reality.

Overall summary of usage of multiple representation –

Interpretation: There's a strong alignment between belief and practice. Teachers who believe in multiple representations are highly likely to incorporate charts and displays into their teaching.

Interpretation: There is good alignment, but not as strong as with charts/displays. Availability appears to be a limiting factor—teachers may believe in the value of science models but lack resources or support to use them consistently.

Interpretation: Here, while belief supports the use of digital tools, lack of access emerges as the biggest barrier. Compared to physical resources like charts or models, digital tools are used less consistently, even when teachers value multiple representations.

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The data suggest:

- Charts/displays are widely used and readily available.
- Science models are moderately used, but availability affects consistent use.
- Digital resources have the lowest consistent use and the highest availability issues, signaling a need for infrastructure and tech support in schools.

ICT availability for science teaching
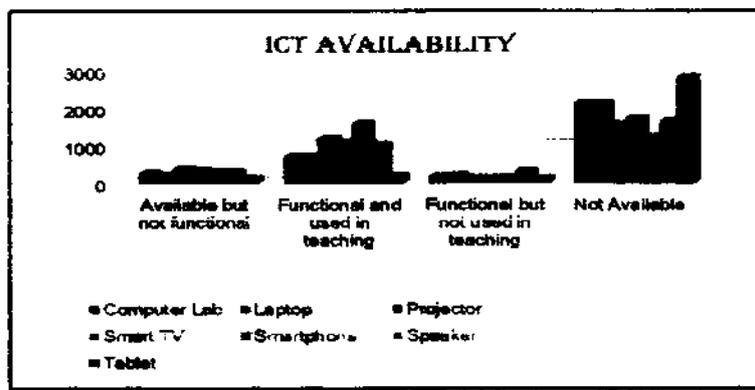
The findings indicate that while some schools have access to ICT resources, a significant number either lack them entirely or have non-functional equipment. **2,138 schools do not have a computer lab, 2,136 lack laptops, 1,565 have no projectors, and 1,735 do not have smart TVs.** In contrast, **1,203 projectors, 1,097 smart TVs, and 1,601 smartphones** are actively used in teaching, reflecting some progress in integrating technology into education. However, a notable portion of ICT tools remains **non-functional, including 268 computer labs, 390 projectors, and 324 smart TVs**, making them unusable despite their presence. Additionally, some functional ICT resources, such as **175 computer labs, 217 laptops, and 135 projectors**, are not being used in teaching, suggesting challenges such as lack of training or inadequate curriculum integration. This imbalance between availability, functionality, and usage highlights the need for better resource management, maintenance, and teacher training to enhance the effectiveness of ICT in education.

- A significant number of ICT tools, such as projectors (1,203) and smart TVs (1,097), are being used in teaching, suggesting that technology integration is improving in many schools.
- However, a large proportion of schools lack basic ICT infrastructure, with **over 2,100** schools reporting no computer lab or laptops, and **more than 1,500** without projectors or smart TVs.

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- Many available ICT tools remain **non-functional or unused**, with **268** non-functional computer labs and **390** projectors that cannot be used. Additionally, **some resources are functional but not utilized in teaching**, such as **175** computer labs and **217** laptops, indicating possible barriers like a lack of training or curriculum integration.

The findings highlight both progress and gaps in ICT adoption in schools. While some institutions effectively integrate projectors, smart TVs, and smartphones into teaching, a **substantial number of schools still lack access to basic digital tools.** The fact that many devices are either non-functional or unused suggests challenges such as poor maintenance, lack of training, or limited digital literacy among educators. Addressing these issues through better infrastructure investment, teacher training, and ICT-focused curriculum enhancements is crucial to improving the use of technology in education.

Frequency of Resource usage in schools
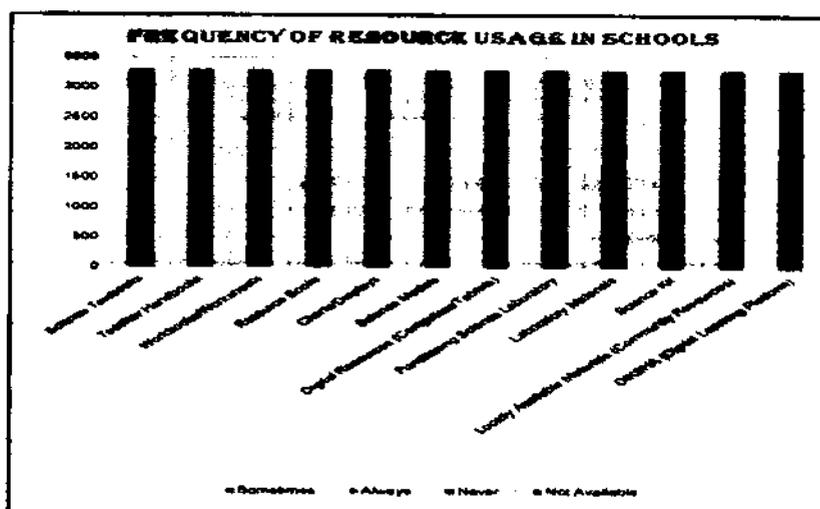
- Science textbooks are the most frequently used resource, with 2,400 schools always using them, 801 using them sometimes, and only 32 never using them. However, 60 schools do not have them at all.
- Teacher handbooks have lower consistent usage, with 1,355 schools always using them, 1,349 using them sometimes, and 79 never using them, while 510 schools lack them entirely.
- Workbooks/worksheets are used always in 1,572 schools, sometimes in 1,163 schools, and never in 69 schools, with 489 schools not having them.
- Resource books have a lower frequency of use, with 1,048 schools always using them, 1,497 sometimes using them, and 99 never using them, while 649 schools do not have access to them.
- Charts and displays are relatively widely used, with 1,512 schools always using them, 1,445 using them sometimes, and 60 never using them, but 276 schools do not have them.

- Locally available materials (community resources) are used sometimes in 1,809 schools, always in 930 schools, and never in 172 schools, while 382 schools reported not having access to them.

The data suggests that **science textbooks are the most consistently used resource**, highlighting their central role in science education. However, **teacher handbooks, workbooks, and resource books** have lower usage rates, with a significant number of schools either using them only sometimes or not having them at all. The lack of **510 teacher handbooks and 649 resource books** suggests that many teachers may be **lacking essential reference materials**, which could affect the depth and effectiveness of their lessons. Similarly, **workbooks are unavailable in 489 schools**, potentially limiting students' ability to practice and reinforce concepts.The **moderate usage of locally available materials** shows that while many schools recognize their importance, they are not consistently incorporated into teaching. The fact that **1,809 schools use them only sometimes** suggests barriers such as **limited teacher training, lack of curriculum alignment, or difficulty in accessing suitable materials**. The **non-availability reported by 382 schools** may indicate either **a lack of awareness or genuine difficulty in identifying local resources** that can be integrated into science lessons.

The findings highlight that while **core learning materials like science textbooks are well-utilized**, the inconsistent use of **teacher handbooks, workbooks, resource books, and locally available materials** could create disparities in the quality of science education. The **underutilization of locally available materials** suggests a need for **better teacher guidance and training** on how to incorporate everyday materials into science lessons effectively. Schools that lack these resources may need **more structured support in identifying and integrating locally available materials** to provide **a more hands-on and practical learning experience** for students. Addressing these gaps by ensuring **better distribution of learning materials and improved teacher training** will be essential for enhancing science education across schools.

Resource adequacy for science teaching

RESOURCE ADEQUACY

Quality of Resources — Quantity of Resources — Accessibility of Resources

■ Somewhat Adequate   ■ Adequate   ■ Not Adequate
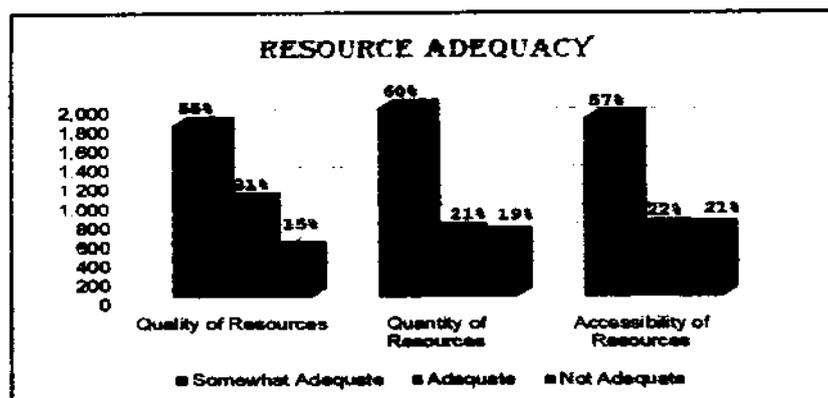
- **Quality of Resources:**
  - o 1798 responses indicated that resources are **somewhat adequate.**
  - o 1007 responses considered the resources **adequate.**
  - o 488 responses stated that resources are **not adequate.**
- **Quantity of Resources:**
  - o 1971 responses indicated that the quantity is **somewhat adequate.**
  - o 686 responses found the quantity **adequate.**
  - o 636 responses reported the quantity as **not adequate.**
- **Accessibility of Resources:**
  - o 1866 responses rated accessibility as **somewhat adequate.**
  - o 721 responses found accessibility **adequate.**
  - o 706 responses considered accessibility **not adequate.**
- The majority of responses indicate that resources are **somewhat adequate** in terms of quality (**1798 responses**), quantity (**1971 responses**), and accessibility (**1866 responses**). This suggests that while resources are present, they may not fully meet the needs of students and teachers.
- Fewer responses categorized resources as **adequate**, with 1007 responses for quality, **686** for quantity, and **721** for accessibility. This indicates that only a small percentage of schools find their resources fully sufficient.
- A significant number of responses (**488 for quality, 636 for quantity, and 706 for accessibility**) categorized resources as **not adequate**, suggesting a notable shortage in some schools.

The data highlights a mixed perception of resource adequacy, with most respondents finding resources only **somewhat adequate** rather than fully sufficient. While a portion of schools report having adequate resources, a substantial number face issues related to **quality, quantity, and accessibility.** The fact that nearly **40% of responses** indicate inadequate resources in at least one category suggests a significant gap that could impact the effectiveness of teaching and learning. Addressing these concerns through improved resource distribution, quality enhancements, and better accessibility measures is crucial to ensuring that all students and teachers have the materials they need for effective education.

Key findings on Interview Data about Resource Availability and usage in science classrooms

Emphasis on Hands-On and Experimental Learning

Highest Response (64 out of 131):

Teachers predominantly use lab equipment, simple circuits, magnets, chemicals, and locally sourced materials. This suggests that many teachers prioritize experiential learning, where students actively engage with physical materials to explore scientific principles. This

hands-on approach fosters curiosity, critical thinking, and problem-solving skills, making learning more interactive and effective.

Use of Visual Aids for Conceptual Clarity

- **Charts, Models, and Visual Aids (58 out of 131):** 2D/3D representations are frequently used for subjects like anatomy,   physics, and chemistry. The high usage of visual aids indicates that   teachers recognize the importance of supporting abstract concepts with tangible representations. This helps students visualize complex ideas, improving comprehension and retention.

Integration of Digital Tools and Multimedia

- **Digital Tools (52 out of 131):** Teachers reported using videos, simulations, and smart boards to illustrate abstract or complex phenomena. The significant reliance on digital tools suggests a   shift toward technology-enhanced learning. Simulations and videos make difficult concepts more accessible, particularly in areas where direct experimentation is challenging.

Less Frequently Used but Impactful Method

Real-Life Connections and Everyday Applications

- **Outdoor observation and linking lessons to real-world experiences (6 out of 131).** While not as frequently mentioned, real-life connections are crucial for contextual learning. Encouraging students to observe natural phenomena or relate science to daily life (e.g., understanding pressure while inflating a balloon) makes learning more meaningful and engaging.

Pre-Assembled Science Kits and Government Resources

- **Kits and Specialized Programs (13 out of 131):** Examples include Prayoga and Agastya, which provide structured science kits. These kits standardize experiments and ensure resource   availability, but their limited usage suggests potential challenges such as accessibility, cost, or lack of training in their implementation.

Limited Usage and Potential Areas for Growth

Interactive, Student-Created Experiments

- **Only 1 mention:** Activities like making pinhole cameras or group experiments were rarely reported. The minimal use of student-created experiments   suggests that there may be constraints in time, resources, or   curriculum   flexibility.   However,

encouraging students to design their own experiments fosters creativity, collaboration, and deeper learning.

Nature as a Learning Resource

- **Only 1 mention:** Using nature to explain concepts (e.g., plant biology, ecosystems) was rarely cited. Despite being a cost-effective and engaging method, this approach is underutilized. Schools might lack outdoor spaces, or teachers may not integrate environmental learning into their lessons effectively.

Low-Cost and No-Cost Materials

- **10 out of 131** Teachers reported using materials that are budget - friendly. While some teachers are leveraging affordable resources, a larger push toward using easily available, cost-effective materials (e.g., kitchen chemistry, paper circuits) could help schools with limited budgets.

Classroom and Unit-Based Resources

- **Resources in the classroom (2) and resources specific to the unit (4)** This suggests that while some teachers tailor resources to specific topics, a more structured approach could enhance lesson planning.

Field Visits, Surveys, and Interviews

- **Only 2 mentions:** Very few teachers reported taking students on field visits or conducting surveys. Despite being valuable for experiential learning, logistical constraints such as cost, permissions, and safety concerns might be barriers. Encouraging more community-based learning could strengthen engagement.

Key findings from Interview data on Challenges for Resource mobilization in science teaching

The data highlights several key challenges in mobilizing resources for science teaching.

The most reported issue is **Infrastructure & Funding (64 responses)**, where teachers face difficulties due to the lack of **dedicated science labs, limited budgets, and unreliable power or internet access**. These challenges directly impact the ability to conduct hands-on science lessons.

Digital Access & Training (58 out of 131 responses) is another major concern, with many schools experiencing a scarcity of digital devices, insufficient teacher training, and language barriers in e-resources. This lack of access to digital tools hinders the integration of technology into science teaching.

In the category of **Classroom Management & Time (52 out of 131 responses)**, teachers struggle with large class sizes, short teaching periods, and the need for resource-sharing. These factors limit opportunities for interactive and practical science activities.

A smaller number of respondents (1 response) identified **Resource Availability & Alignment** as a challenge, citing outdated or missing equipment, chemical shortages, and difficulty in sourcing age-appropriate local content. Though this issue was reported less frequently, it still impacts the quality of science education.

Teacher Workload & Professional Support (6 out of 131 responses) highlights the burden of heavy administrative duties, minimal peer collaboration, and limited professional development opportunities. These constraints can reduce teachers' efficiency and motivation.

Another issue raised is **Student Engagement & Parental Support (13 out of 131 responses)**. Low student participation, along with a lack of parental cooperation, affects students' interest in science learning.

Interestingly, only **one respondent indicated no challenges (1 out of 131 response)**, suggesting that almost all educators face some level of difficulty in resource mobilization for science teaching.

The most prevalent challenges are **Infrastructure & Funding, Digital Access & Training**, and **Classroom Management & Time**. This suggests that the lack of financial support, technological resources, and effective classroom structures significantly hinder science education. Without adequate infrastructure, teachers cannot conduct practical experiments, and students miss out on crucial hands-on learning experiences. Less commonly reported issues, such as **Resource Availability & Alignment and No Challenges**, indicate that while outdated equipment is a concern, it is not seen as the most pressing issue when compared to broader funding and infrastructure problems. The findings also reveal that **teacher workload and lack of professional support** contribute to burnout, reducing their effectiveness in delivering science lessons. Additionally, **student engagement and parental involvement** remain concerns, as science education requires active participation, which is often lacking.

The data clearly shows that **financial and infrastructure constraints** are the biggest barriers to effective science teaching. Without dedicated labs and sufficient funding, teachers struggle to create interactive learning environments that promote scientific inquiry. Another significant challenge is the **digital divide in science education**. Many schools lack access to essential digital tools, and teachers do not receive enough training to integrate technology effectively into their lessons. This gap limits students' exposure to modern scientific methods and resources. Classroom overcrowding and **time limitations** further exacerbate the problem, making it difficult to conduct practical experiments. As a result, students may rely more on theoretical learning, which is less engaging and less effective in developing scientific skills. The **lack of**

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professional development and administrative burden on teachers also affects the quality of science education. Teachers need more opportunities for peer collaboration and training to enhance their teaching methods. Finally, **low student engagement and limited parental support** make it harder to sustain interest in science. If students are not actively participating and parents are not encouraging science learning at home, the overall effectiveness of science education diminishes.

4.4 Challenges faced by teachers

Overview of challenges faced by science teachers
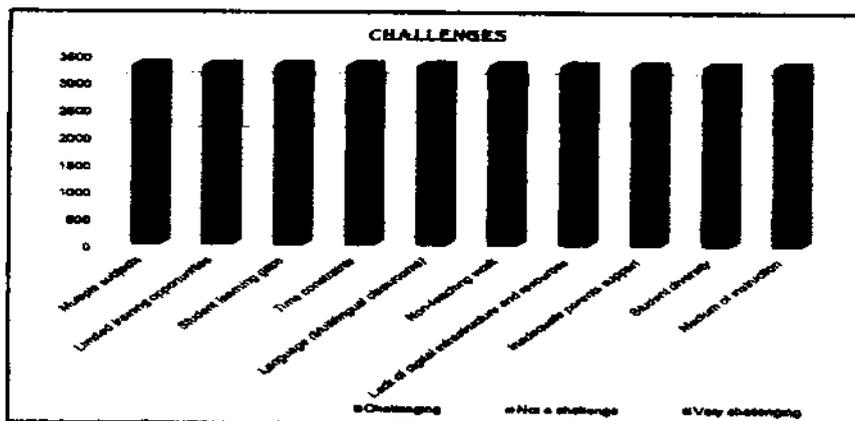
- The most significant challenges (highest proportion of "Very Challenging" responses) include:
    a. Lack of digital infrastructure and resources
    b. Student learning gaps
    c. Time constraints
    d. Inadequate parental support
- "Medium of instruction" stands out as a unique challenge where fewer responses fall under "Very Challenging," but a high proportion still finds it "Challenging."
- Limited training opportunities and multilingual classrooms are major concerns, indicating a need for better teacher professional development and support for diverse student needs.
- Resource-related issues (lack of digital infrastructure, teaching resources) significantly impact teaching effectiveness.
- Time constraints and non-teaching work reduce teachers' ability to focus on direct student learning.
- Parental involvement is insufficient, which may contribute to student learning gaps and behavioral challenges.
- Student diversity and multilingual classrooms create additional burdens, requiring tailored teaching strategies and inclusive policies.

Challenge - Multi-grade teaching
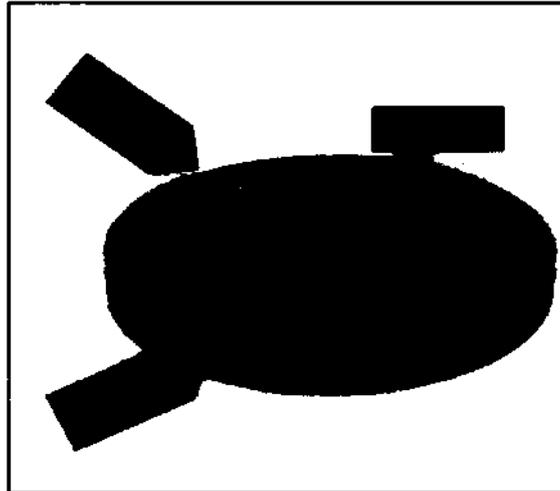
Key Findings:

- 45.85% of teachers reported multigrade teaching as "Challenging". This indicates that nearly half the respondents face notable difficulties in managing diverse learning needs, time allocation, and content delivery in such classrooms.

- 21.14% described it as "Very challenging", suggesting a high level of stress or struggle among over one-fifth of the teachers. These teachers likely face serious constraints such as limited resources, large class sizes, or lack of training.

- 33.01% reported that it was "Not a challenge". This positive response could reflect the presence of supportive infrastructure, prior experience, or effective strategies used by these teachers to manage multigrade classrooms.

Implications:

- A total of 67% of teachers (combining "Challenging" and "Very challenging") find multigrade teaching to be a problem, signaling the need for targeted interventions such as:
    - Professional development on multigrade pedagogy
    - Structured teaching-learning materials (TLMs)
    - Peer or community support mechanisms
    - Smaller class sizes or additional teacher deployment
- The 33% who do not find it challenging could serve as resource persons or mentors to others, sharing best practices and locally developed solutions.

Challenge - Lack of academic support

Total
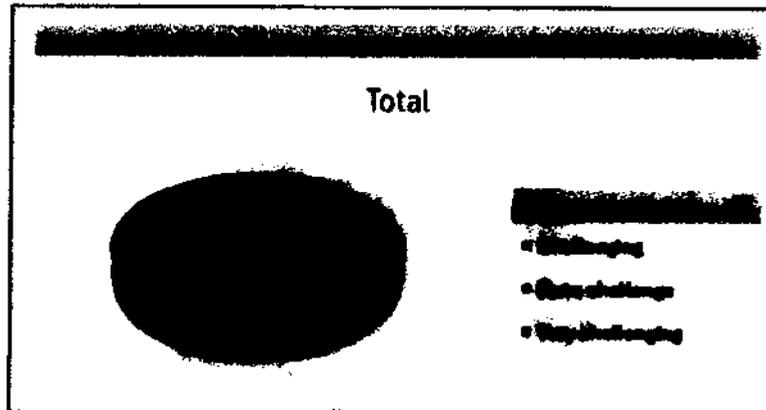
Key Findings:

- 32.34% of teachers found the lack of academic support to be "Challenging". This indicates that nearly one-third of the respondents experience noticeable difficulty in receiving timely or relevant pedagogical guidance from supervisory or support staff.
- 11.81% rated it as "Very challenging", highlighting that over one in ten teachers feel the absence of support as a significant barrier to effective teaching.
- 55.85% reported it as "Not a challenge", suggesting that a majority of teachers either:
- Receive adequate academic support from the system, or
- Have adapted to managing teaching responsibilities independently, possibly using peer networks or self-developed strategies.

Interpretation and Implications:

- 44.15% of teachers (combining "Challenging" and "Very challenging") feel a lack of adequate academic support—a substantial portion that points toward gaps in mentoring, classroom observations, feedback mechanisms, and in-service training.
- The high percentage (55.85%) who do not perceive it as a challenge may be indicative of:
  - Regional or institutional variations in support
  - Differences in expectations from the support system
  - High levels of teacher self-efficacy

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Challenge- Time Constraint

Total
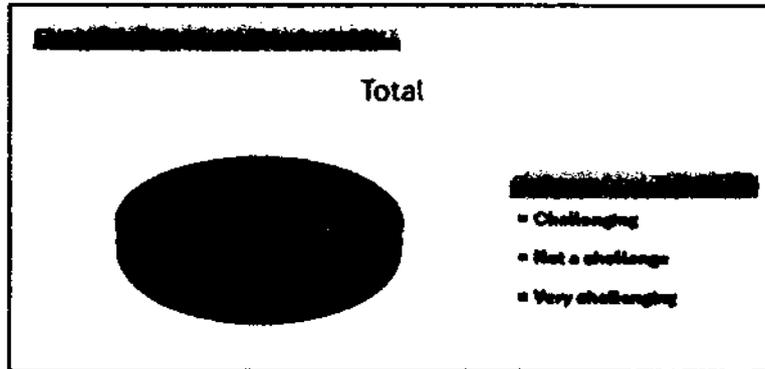
Key Insights

- A large majority (82.26%) of teachers experience time constraints as a challenge or a major challenge, underlining this as one of the most severe issues.
- Only 17.73% of respondents do not see time constraint as a challenge, suggesting that for most teachers, time is a limiting factor in planning, instruction, or assessments.
- The high percentage of "Very Challenging" responses (27.57%) indicates that this isn't just a minor inconvenience—it's a systemic hurdle that could be affecting instructional quality.

Interpretation

- Teachers may be overloaded with administrative responsibilities or large class sizes, leaving insufficient time for lesson planning, personalized support, or even self-learning.
- The burden could be higher in multigrade classrooms or schools with limited staff.

Challenge: Multi-grade teaching Vs time constraint
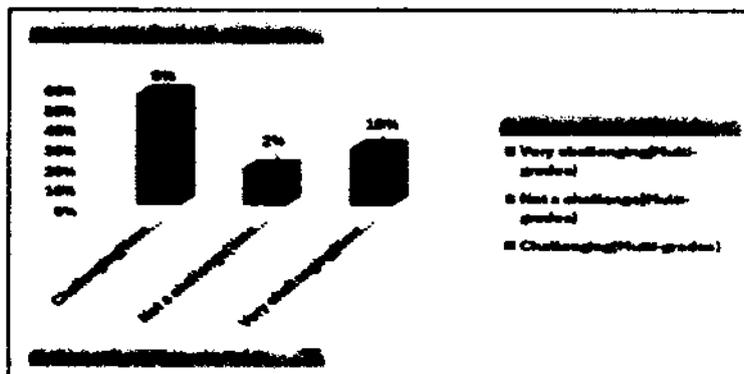
Overlapping Challenges

- **28%** of teachers who find multigrade teaching challenging also find time constraints challenging, showing a strong overlap.
- Similarly, **10%** of teachers who find both multigrade teaching and time constraints very challenging highlight a critical subgroup under severe strain.

Less Impacted Segment

- Only **6%** of teachers who found multigrade teaching challenging felt that time constraints were not a challenge, indicating that time constraints usually coexist with the difficulties of multigrade teaching.
- Conversely, **10%** of teachers found neither multigrade teaching nor time constraints to be major challenges, forming a minority subgroup.

Overall Burden

- **83%** of teachers (55% + 28%) report at least one of the two issues as challenging or very challenging.
- The high degree of intersection suggests that addressing one challenge in isolation may not be sufficient—they need to be tackled together.

Insights and Implications

- Multigrade classrooms appear to intensify the issue of time constraints, likely due to the complexity of planning and managing instruction for multiple levels at once.
- Teachers under dual pressure may experience burnout or reduced instructional effectiveness.
- These insights emphasize the need for:
  - Differentiated instructional tools for multigrade settings.
  - Reduced administrative burden.
  - Timetable flexibility or teaching assistants where possible.

Challenge - Time constraints Vs lack of administrative support
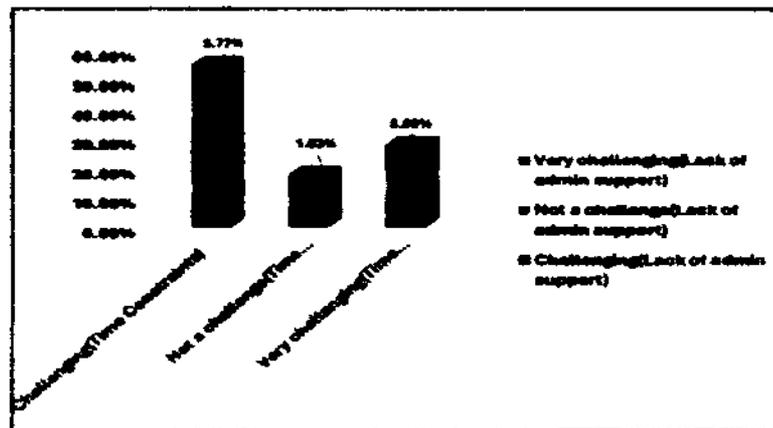
Insights from the Data

- Majority Experience Dual Challenges: A large portion of respondents (869 out of 1801) who find *time constraints challenging* also report *lack of administrative support as challenging.*

- Intensified Challenges Correlate: Of those who find both factors *very challenging*, 296 responses were recorded, highlighting a strong correlation between these two stressors.

- Comparative Totals:
  Challenging (Admin Support): 1292 responses
  Not a Challenge (Admin Support): 1481 responses
  Very Challenging (Admin Support): 520 responses
  Overall Trends from the Chart:

- Around 22.53% of teachers find both *time constraints and lack of admin support* very challenging.

- Only 5.77% reported *very challenging* time constraints without admin support issues.

- 26.38% marked time constraints as challenging even when they did not view admin support as an issue.

Interpretation & Implications

- **Interdependency of Challenges:**
  Teachers who struggle with administrative inefficiencies also report time management as a major obstacle. This may point to systemic bottlenecks in communication, scheduling, or resource allocation.

- **Support Systems Are Critical:**
  Those reporting "Not a challenge" in administrative support were far less likely to report severe time constraints, reinforcing the value of effective leadership and organizational backing.
- **Need for Targeted Interventions:**
  Improving administrative responsiveness could potentially alleviate time-related stress among teachers.

Time constraint Versus Teacher shortage
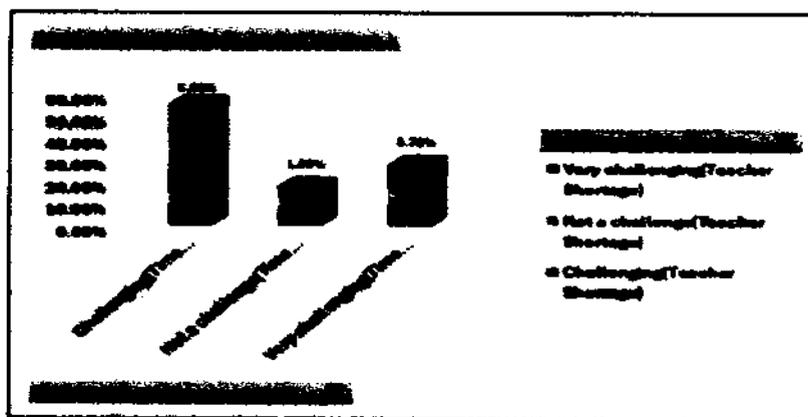
Key Observations

- **Most teachers report dual challenges:**
  Over **54%** of teachers find time constraints to be challenging, and many of these also report some level of teacher shortage, with **24.17%** finding both to be *challenging*.
- **Intensely challenging scenario:**
  9.72% of respondents find both teacher shortage and time constraints to be *very challenging*, indicating a compounded issue likely affecting teaching quality and morale.
- **Moderate issue segments:**
  - **22.44%** find teacher shortage not a challenge, despite finding time constraints challenging.
  - **11.72%** find teacher shortage not a challenge and time constraints not a challenge — this is the most favorable scenario.
- **Less intense overlap:**
  A relatively small percentage (1.58%) found time constraints not challenging but still flagged teacher shortage as *very challenging*, indicating teacher shortage can be a standalone challenge in some cases.

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Insights & Implications

- **Systemic Interlinkage:**
  Time constraints appear closely linked with teacher shortages. Fewer staff likely increases workload, amplifying time-related pressure.
- **Crisis pockets:**
  Nearly 10% of teachers are in a high-stress zone (very challenging for both areas), requiring urgent intervention.
- **Buffering Effects:**
  Where teacher shortage isn't seen as a challenge, there's a notable relief on time pressure. This suggests adequate staffing acts as a buffer against time-related stress.

Time constraint versus low attendance
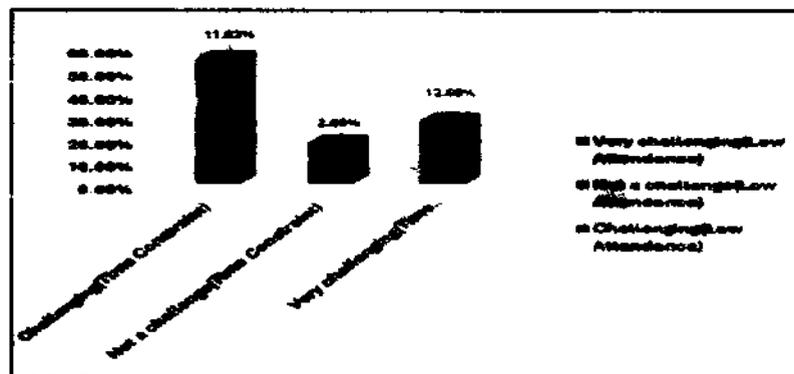
Key Observations

- **High dual challenge zone:**
  13.60% of respondents identified both time constraints and student low attendance as *very challenging*. This group likely faces compounding issues in classroom management and student engagement.
- **Largest segment:**
  The highest percentage (29.33%) represents those who found both time constraints and student low attendance as *challenging*, showing that even at moderate levels, the combination is widespread.
- **Relief zones:**
  8.38% of teachers reported *no challenge* in either category, representing a small but important segment where systems may be functioning better.
- **Mid-tier strain:**
  11.63% of teachers find low attendance very challenging even though they experience only *moderate time constraints*. This implies that absenteeism can be a severe standalone issue.

Insights & Implications

- **Correlation of Challenges:**
  Teachers who experience time pressure are also likely to struggle with low attendance, which may hinder lesson continuity and planning.

- **Impact on Teaching Effectiveness:**
  Teachers experiencing both high time constraints and poor attendance may face barriers in covering the syllabus effectively, conducting assessments, and maintaining classroom discipline.

- **Targeted support needed:**
  Those facing "very challenging" levels in both domains should be prioritized for administrative support, teaching aids, and attendance interventions.

Challenge - Time Constraint versus non-teaching work
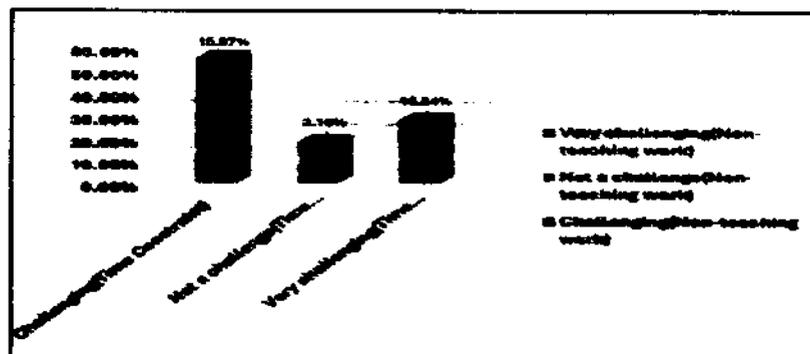
Key Observations

- **Heavy burden intersection:**
  A significant 16.34% of teachers report both time constraints and non-teaching work as *very challenging*, signaling a high-stress segment that may be overwhelmed by dual responsibilities.

- **Most common overlap:**
  26.78% found time constraints *challenging* and simultaneously found non-teaching work also *challenging*, indicating this combination is the most frequent stress point.

- **Moderate challenge relief zones:**
  8.75% of teachers experience *no challenge* with time or non-teaching duties, highlighting a functioning subgroup that could serve as a model for better resource allocation.

- **Intensely affected group:**
  15.97% of teachers marked non-teaching work as *very challenging* despite only marking time constraints as *challenging*, showing how burdensome administrative tasks can be even without severe time pressure.

Insights & Implications
- **Non-teaching tasks add significant pressure:**
  Tasks outside core instructional duties are heavily linked to time constraints. Even those with otherwise manageable time loads are impacted by non-teaching obligations.
- **Core teaching time at risk:**
  Teachers overwhelmed by administrative duties likely struggle to allocate sufficient time to lesson planning, student support, and assessments.
- **Support inequality:**
  A notable portion of teachers (especially the 16.34% at the severe end) are likely not receiving enough clerical or systemic support.

Insights

- **Time is the Common Denominator:**
  Regardless of the challenge type, time constraints consistently magnify the stress. This implies that interventions targeting time management and task simplification can yield cross-cutting benefits.
- **Non-teaching Duties Are a Crisis:**
  With over 43% of teachers finding non-teaching tasks either *challenging* or *very challenging* along with time constraints, there is clear evidence that administrative burden must be addressed.
- **Multigrade & Teacher Shortage Go Hand-in-Hand:**
  These often co-occur in the same regions, exacerbating the issue. Structural reforms in rural education planning are essentials

Time constraints don't exist in isolation—they are intensified by structural, administrative, and social challenges. Targeted policies that reduce workload, improve support systems, and recognize the complexity of teaching roles are urgently needed.

Comparison of challenges faced by HPS and HS Teachers

58
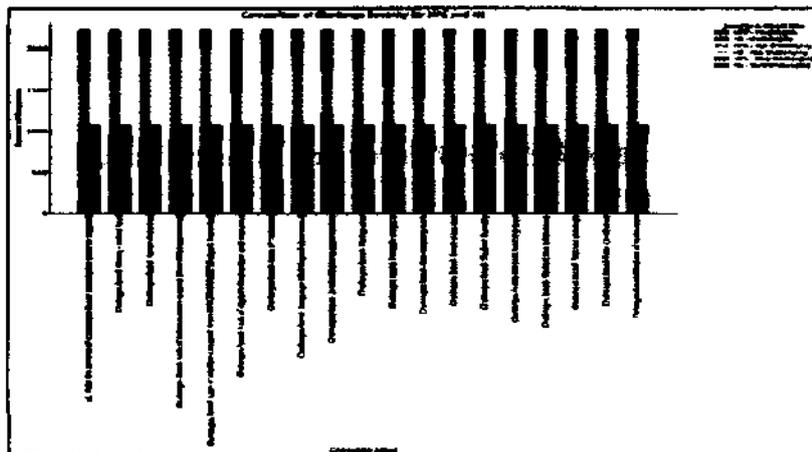
Challenges are more severe in HPS (Higher Primary Schools) compared to HS (High Schools)

- HPS has a higher proportion of "Very Challenging" responses (solid red), while HS has more "Challenging" responses (solid blue).

Common severe challenges across both school types:

- o Inadequate parental support
- o Heavy content load
- o Large class sizes
- o Lack of digital infrastructure and resources
- o Student learning gaps

HPS experiences greater severity in administrative and academic support challenges.

- The lack of support from **higher education bodies** appears more pressing in HPS.
- **Time constraints and multiple subjects are a significant challenge for both school types,** but HPS shows a higher proportion of "Very Challenging" responses.
- **HPS faces higher expectations, workload, and academic pressure** compared to HS, leading to more reported severity in challenges.
- **Large class sizes and student learning gaps** indicate systemic issues affecting teaching effectiveness across both school types.
- **HPS struggles more with administrative and academic support,** likely due to stricter performance standards and accountability measures.
- **Limited training opportunities and inadequate resources are persistent challenges,** regardless of school type.

The findings reveal that there is an urgent need for Targeted Administrative Support for HPS: Increased backing from educational bodies is necessary to alleviate burdens.

Curriculum Adjustments: The heavy content load issue suggests a need for curriculum restructuring or better resource allocation.

Improved Infrastructure and Digital Resources: Investment in digital tools, especially for HPS, could ease workload challenges.

Parental Involvement Programs: Strengthening engagement with parents could help reduce student learning gaps.

Comparison of challenges faced by Rural and Urban teachers for science teaching
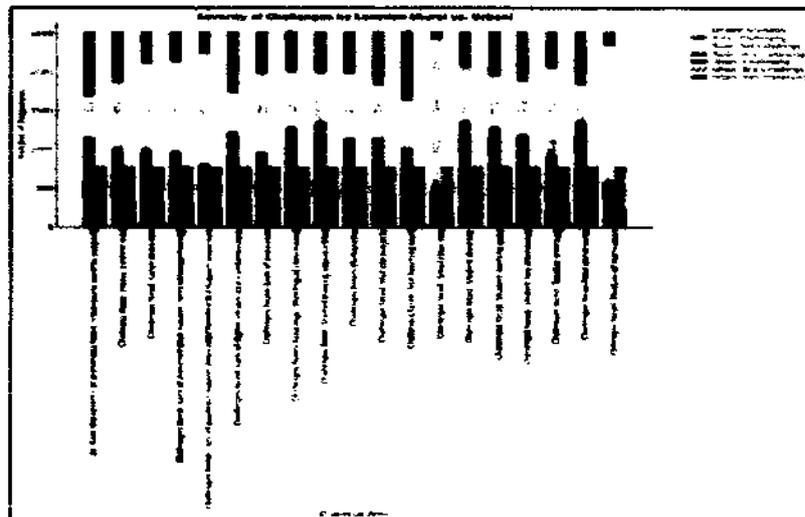
Rural schools face significantly greater challenges than urban schools.

- The red bars (Rural - Challenging) and dark red bars (Rural - Very Challenging) are more prominent compared to the striped urban equivalents.
- This suggests rural schools struggle more with most challenges.

Top severe challenges in rural schools:

- o Lack of digital infrastructure and resources
- o Inadequate parental support
- o Student learning gaps
- o Heavy content load
- o Limited training opportunities
- o Multigrades (teachers managing multiple grades in one classroom)

Urban schools have relatively fewer "Very Challenging" responses.

- While urban schools still report challenges, they are generally less severe compared to rural schools.
- Urban schools show more yellow (Not a Challenge) and striped, green (Very Challenging - Urban), indicating a less extreme experience.
- Multilingual classrooms and student diversity are more significant in urban areas.
- Urban schools show a higher presence of striped green in "Language (Multilingual classrooms)" and "Student Diversity," meaning these are bigger concerns in city schools.

- Rural schools suffer from a lack of infrastructure, resources, and teacher support, which contributes to higher difficulty levels in most areas.
- Digital divide is a key issue—rural schools struggle with digital infrastructure, academic resources, and support from educational bodies.
- Parental involvement is lower in rural areas, possibly due to socio-economic challenges or lower literacy levels among parents.
- Urban schools face unique challenges related to student diversity and multilingual classrooms. This may indicate a need for language support programs and culturally inclusive teaching strategies.

Key findings from Teachers interview data about Challenges of science Teaching

The data highlights several key challenges in science education, categorized into six major areas: **Student Gaps and Engagement, Abstract Content and Language, Resource Limitations, Time and Class Size, Pedagogical and Assessment Hurdles, and Socio-Cultural Barriers.** The numbers associated with each category indicate the frequency or severity of these challenges as perceived by educators. Below is a detailed breakdown of each category.

Student Gaps and Engagement (92 out of 131 Responses) – The Most Pressing Issue

The most frequently cited challenge is student gaps and engagement. This suggests that teachers struggle with students who lack foundational knowledge, have low motivation, exhibit irregular attendance, and find it difficult to grasp scientific terminology. These issues are critical because they directly affect learning outcomes. If students lack motivation and foundational understanding, they are less likely to engage with complex scientific concepts. This finding underscores the need for remedial programs, differentiated instruction, and interactive teaching methods to boost student motivation and engagement. Strategies such as hands-on experiments, real-world applications, and gamified learning could help bridge these gaps and make science more accessible and interesting for students.

Time and Class Size (76 out of 131 Responses) – A Major Structural Barrier

A significant number of responses point to large class sizes and time constraints as major barriers to effective science education. Teachers struggle with managing large classrooms, which limits their ability to provide individual attention and hands-on learning experiences. Administrative duties further take up valuable instructional time, reducing opportunities for interactive teaching. This issue highlights the need for better teacher-student ratios, additional support staff, and policies that reduce the administrative burden on teachers. Implementing peer-assisted learning, flipped classrooms, and smaller learning groups could help maximize engagement despite class size limitations.

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Resource Limitations (27 out of 131 Responses) – Hindrance to Practical Learning

The lack of science labs, teaching-learning materials (TLMs), and digital infrastructure significantly hampers science education. Science is a hands-on subject, and without practical demonstrations, students struggle to grasp abstract concepts. This finding suggests that many schools lack the necessary infrastructure to provide students with experiential learning opportunities. To address this, investment in science laboratories, access to digital resources, and mobile science kits is crucial. Government policies and partnerships with educational technology providers could help bridge the gap by introducing low-cost but effective solutions, such as virtual labs and open-source digital science tools.

Pedagogical and Assessment Hurdles (37 out of 131 Responses) – Need for Teacher Training

Teachers express concerns about needing more targeted training, better assessments, and a balance between theory and experiments. This highlights the need for professional development programs that equip educators with modern instructional and assessment techniques. Training programs should focus on inquiry-based learning, formative assessments, and integrating technology in science education. Additionally, teachers could benefit from collaborative learning communities where they share best practices and innovative teaching methods.

Abstract Content and Language (27 out of 131 Responses) – The Complexity of Scientific Concepts

A significant challenge in science education is the complexity of scientific ideas and inadequate translation into local languages. Many students struggle with technical terminology, which creates a barrier to understanding. This is particularly problematic for students from non-dominant language backgrounds. Addressing this challenge requires bilingual teaching materials, simplified explanations, and visual aids. Schools can introduce localized examples and storytelling techniques to make complex scientific ideas more relatable. Additionally, using interactive simulations and models can help students grasp difficult concepts without relying solely on text-based explanations.

Socio-Cultural Barriers (23 out of 131 Responses) – External Factors Affecting Student Participation

The least frequently mentioned, but still significant, challenge is socio-cultural barriers, such as parental indifference, misconceptions about science, and financial constraints. Many parents may not actively support their child's science education due to lack of awareness or misconceptions about the subject's importance. Financial limitations further restrict access to additional learning resources, private tutoring, or science-related extracurricular activities. Community engagement programs, parental awareness campaigns, and affordable science education initiatives could help

address these barriers. Schools and policymakers should work together to make science education more inclusive and accessible to students from all backgrounds.

Key findings from FGD about challenges in science teaching

Timetable:

- The timetable has dedicated periods for each subject. It is often very difficult to set up an experiment or provide hands-on experience to the students in the stipulated time. It would be helpful if the time allocated for the science period were at least one hour. Else, there should be dedicated lab periods of at least 2 per week.
- Teacher availability is a crucial aspect for an effective science education. At high school, availability of both CBZ and PCM teachers ensures effective classroom instruction. It becomes difficult for CBZ teachers to teach physics concepts effectively.
- The above aspect also has direct implications while planning and conducting capacity building interactions. There should be a correspondence between the theme of the interaction and the teachers selected to participate in it. For example, for workshops on topics related to Physics, allowing PCM teachers to participate in the workshop is more effective.

Curriculum and Annual Academic Calendar

- Science textbook should contain reference to "vocations" as and when a topic lends opportunity to. The curriculum ought to be in line with the real-life applications, ensuring enough avenues for "working with hands". It should not end up making more students devoid of employable skills
- Annual academic calendar guides to conduct different programs that impact the time available for classroom instruction. The documentation work, post the event completion takes time too.
- Non-curricular activities also require a lot of time. Sometimes these simultaneous responsibilities impact classroom instruction.
- Teachers believed the current curriculum to be transacted in line with the expectations of the policy documents demands a lot of time.
- Teachers shared that the textbooks, even though they focus a lot on activity-based learning, also leave certain sections blank. This sometimes makes using textbooks as self-learning resources a bit difficult.
- Teachers of higher primary sections felt that textbooks have been toned down a lot making it difficult for the students to comprehend concepts as they proceed to higher grades (for example, when they move to high school from higher primary school)
- Assessment is majorly a pen-paper test. Teachers stated that examination structure that currently being followed is majorly a pen-paper test lending limited scope to assess process skills.

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- Challenges in Teaching Science – There is not always enough time to teach science properly because of too much workload. But using practical experiments, technology, and hands-on activities can help students understand better and remember what they learn.

4.5 Key Findings of Classroom observation Data

Classroom teaching learning processes
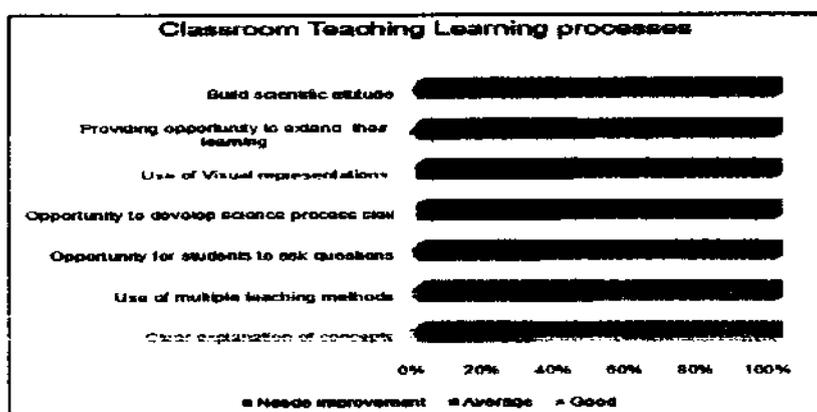
The bar chart presents an evaluation of various aspects of classroom teaching-learning processes in science education.

The responses are categorized into three levels:

Strengths in Classroom Practices
Several aspects of teaching are rated highly in terms of effectiveness:
i. **Clear explanation of concepts (68% rated as Good)** – This indicates that a majority of teachers effectively clarify scientific concepts.
ii. **Opportunity for students to ask questions (66% Good)** – Teachers seem to encourage student participation and curiosity, which is key to inquiry-based learning.
iii. **Building a scientific attitude (61% Good)** – Most teachers are fostering a mindset that promotes questioning and logical reasoning.
iv. These findings suggest that science classrooms are generally succeeding in key pedagogical areas essential for conceptual understanding.

Areas for Improvement
While a majority of teachers receive positive ratings, some areas require attention:
v. **Use of multiple teaching methods (45% rated as Average, 5% Needs Improvement)** – A considerable portion of teachers rely on limited strategies, indicating a need for professional development in diverse instructional approaches.
vi. **Use of visual representations (31% Average, 13% Needs Improvement)** – The relatively higher percentage in the "Needs Improvement" category suggests that more emphasis on diagrams, models, and simulations could enhance learning.

Moderate Performance Indicators

Some teaching strategies have a mix of ratings, indicating varying effectiveness:

vii. **Providing opportunities to extend learning (57% Good, 39% Average)** – While a majority of teachers are fostering deeper engagement, a significant portion may need to improve their approach to extending students' learning beyond basic instruction.

viii. **Opportunity to develop science process skills (60% Good, 33% Average)** – Although a majority receive a positive rating, further emphasis on practical experimentation and hands-on activities could strengthen this area.

Lesson Structure
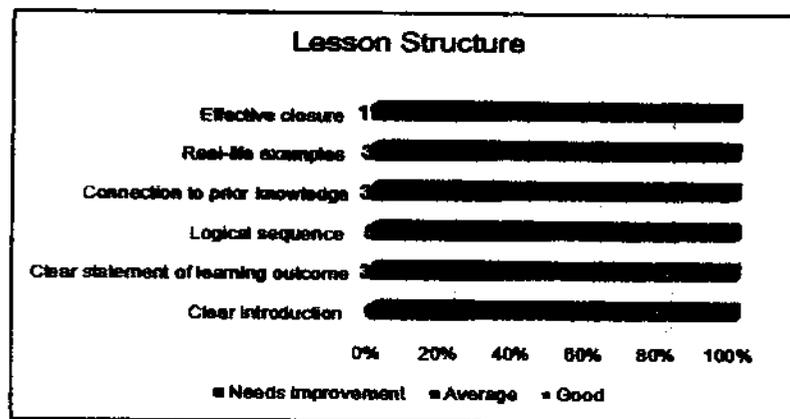
Strengths in Lesson Planning and Execution

- Clear Introduction (73% Good): Most teachers effectively introduce lessons, setting a strong foundation for student engagement.
- Use of Real-life Examples (67% Good): A majority of teachers connect lessons to real-world applications, enhancing conceptual understanding.
- Clear Statement of Learning Outcomes (64% Good): Ensuring students understand the goals of the lesson is a widely adopted practice.
- Effective Closure (64% Good): Many teachers successfully summarize key takeaways at the end of lessons.

## Areas for Improvement

- Logical Sequence (43% Average, 5% Needs Improvement): While most lessons are structured well, a notable percentage of teachers struggle with maintaining a logical flow in their teaching.
- Connection to Prior Knowledge (33% Average, 3% Needs Improvement): Some teachers need to improve in linking new content with students' previous learning experiences.

Key Insights from the Data

- Lesson Introduction and Real-Life Examples Are Strong Areas: Teachers excel in making lessons engaging from the beginning and relating concepts to practical applications.
- Lesson Closure Is Well-Implemented: Effective summarization of lessons is a common practice, helping students consolidate learning.
- Logical Sequence and Concept Linking Need Attention: Some teachers need support in ensuring a smooth transition between concepts.

Status of Resource usage and availability

Status of resource usage and availability
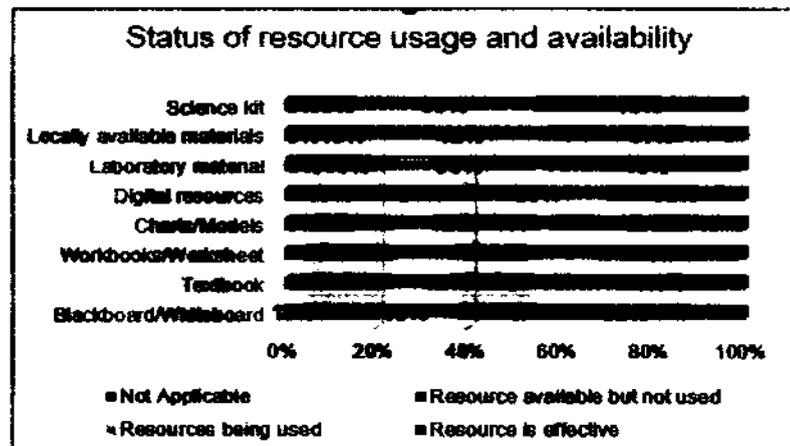
Strengths in Resource Utilization

- Blackboard/Whiteboard (52% Effective) is the most utilized and effective resource, indicating a strong reliance on traditional teaching aids.
- Textbooks (44% Effective) and Workbooks/Worksheets (32% Effective) are actively used, highlighting their importance in science education.
- Science Kits (46% Effective) and Laboratory Materials (43% Effective) are recognized as effective resources, reinforcing the hands-on nature of science learning.

Areas of Concern and Underutilization

- Digital Resources (21% Available but Not Used, 30% Being Used, 30% Effective) – Despite availability, digital tools remain underutilized, possibly due to lack of training, infrastructure, or confidence in integrating technology into teaching.
- Charts/Models (42% Being Used, 43% Effective) – While effective, a significant proportion of teachers (8%) still report not using them, suggesting a need for better integration into lessons.
- Locally Available Materials (42% Being Used, 41% Effective) – These are practical and cost-effective, yet some teachers do not make full use of them.

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Key Insights from the Data

- Traditional resources like blackboards, textbooks, and science kits are widely used and considered effective.
- Workbooks and worksheets are being used (44%), but their effectiveness (32%) suggests they may not always contribute significantly to learning.
- Digital resources show the highest level of underutilization (21% Available but Not Used), emphasizing the need for digital literacy and better infrastructure.

Status of Digital Resources:
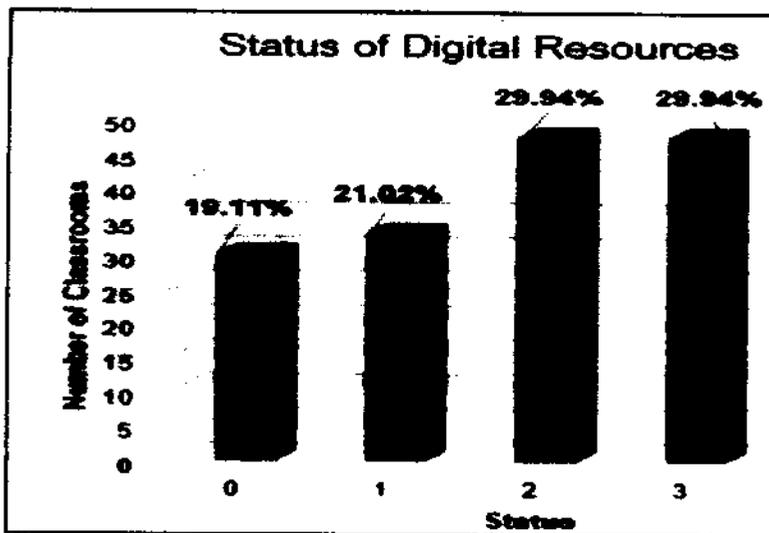
It was observed that

i.   19% of the classes do not have any digital resources to use while teaching
ii. 21% of the classes had access to digital resources but couldn't use while teaching
While 30% of the classes used these resources effectively, another 30% could have used it even better.

The fact that nearly 40% of classrooms (Status 0 and 1) either lack or have minimal digital resources suggests an urgent need for investment in educational technology.

Most classrooms (Status 2 and 3) have some level of digital integration, but there is still a divide between those with adequate resources and those without

The equal percentage of moderately and well-equipped classrooms (29.94%) shows that while progress is being made, not all classrooms have reached an optimal digital resource level

Assessment and Feedback

Assessment and Feedback

Addressing misconceptions
Constructive feedback
Using different modes of assessment
Ensures attainment of learning outcomes

0%   20%   40%   60%   80%   100%

■ Needs improvement   ■ Average   ▲ Good
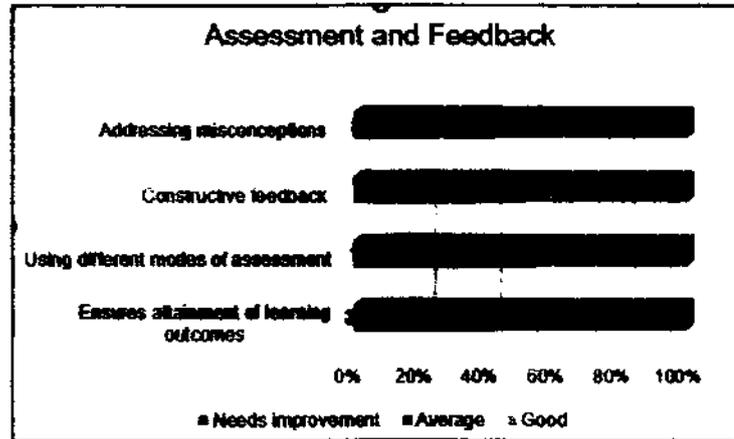
Strengths in Assessment and Feedback

- Ensuring attainment of learning outcomes (58% Good) – A majority of teachers are confident in helping students meet learning objectives, indicating effective instructional alignment with curriculum goals.
- Addressing misconceptions (57% Good) – More than half of the teachers effectively correct students' misunderstandings, crucial for strengthening conceptual clarity.

These findings suggest that teachers prioritize conceptual understanding and student progress in their assessment strategies.

Areas for Improvement

- Using different modes of assessment (10% Needs Improvement, 44% Average) – A significant portion of teachers rely on limited assessment strategies, indicating a need for diversification beyond traditional testing methods.
- Constructive feedback (9% Needs Improvement, 43% Average) – While nearly half of the teachers provide feedback at an average level, further emphasis on timely and detailed feedback can enhance student learning.

Moderate Performance Indicators

- While teachers are actively addressing misconceptions (57% Good), the 35% rating as Average suggests that some teachers may not have the necessary strategies to correct misunderstandings effectively.
- Attainment of learning outcomes (58% Good, 39% Average) indicates a strong instructional foundation, but some teachers may need additional support to bridge gaps in student learning.

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4.6 Training Needs and Recommendations

Areas of workshop impact
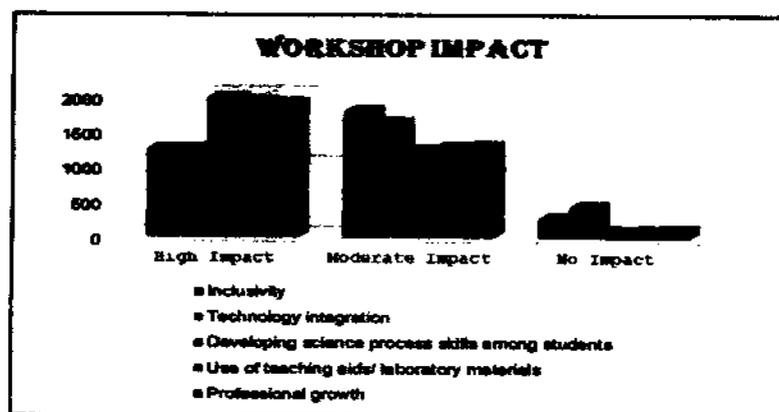
The workshop had a **high impact** on key teaching aspects, with **technology integration, developing science process skills, and the use of teaching aids/laboratory materials** being the most positively affected areas. These three aspects show the highest number of respondents indicating a **high impact**, suggesting that the workshops effectively enhanced practical teaching approaches. A significant number of participants also reported a **moderate impact** across all areas, particularly in **inclusivity and professional growth**, suggesting that while the workshops were beneficial, some teachers may require additional support or follow-up training. The **no impact** category has the lowest number of responses, but **technology integration** and **inclusivity** show slightly higher values in this section, indicating that some teachers did not find the workshop effective in these aspects.

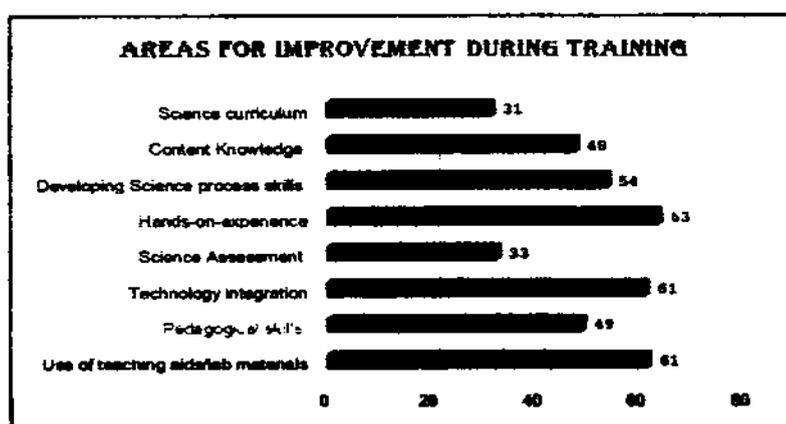The data suggests that the workshops were generally **successful in improving teaching practices but had varying degrees of effectiveness across different areas**. The high impact on **technology integration and the use of teaching aids** reflects that teachers gained valuable skills in incorporating digital tools and hands-on materials into their teaching. However, the **moderate impact on inclusivity and professional growth** suggests that while these areas were addressed, they might need more targeted training. Inclusivity, in particular, may require **more specialized workshops** that focus on catering to diverse student needs. The presence of a **small percentage reporting no impact** implies that some teachers may not have fully benefited from the workshop, possibly due to **differences in prior knowledge, training duration, or applicability to their specific teaching environments**.

The workshop appears to have **successfully enhanced practical teaching skills**, particularly in **technology integration, science process skills, and laboratory-based learning**. These findings indicate that **teachers are receptive to hands-on and technology-driven training**, which should be further reinforced in future professional development programs. However, the

moderate impact on inclusivity and professional growth suggests a need for more focused training in these areas. Future workshops should incorporate case studies, differentiated instruction strategies, and mentorship programs to better support inclusivity and teacher career development. The presence of a small percentage of teachers reporting no impact highlights the importance of individualized follow-up support. Offering personalized coaching, post-workshop resources, and ongoing peer collaboration could help ensure that all teachers benefit fully from training programs.

Areas for improvement in Training programs

AREAS FOR IMPROVEMENT DURING TRAINING

| Category	Value
Science curriculum	31
Content Knowledge	48
Developing Science process skills	54
Hands-on-experience	63
Science Assessment	33
Technology integration	61
Pedagogical skills	49
Use of teaching aids/lab materials	61

The most critical area for improvement identified in the chart is **hands-on experience (63%)**, indicating that teachers feel a strong need for more practical engagement in their training. This is closely followed by **the use of teaching aids and lab materials (61%)**, suggesting that many educators lack sufficient resources or training to effectively incorporate these tools into their teaching. Similarly, **technology integration (61%)** is a major concern, highlighting the necessity for improved digital literacy and access to EdTech tools in the classroom. Moderately significant areas of improvement include **developing science process skills (54%)** and **pedagogical skills (49%)**, pointing to the need for better teaching strategies that foster scientific thinking and active learning. Additionally, **content knowledge (48%)** shows that nearly half of the respondents feel they require deeper subject matter expertise to effectively teach science concepts. On the lower end, **science assessment (33%)** is seen as a less pressing concern, suggesting that while educators recognize the importance of assessment, it does not pose as great a challenge as other aspects of teaching. The least mentioned area is **science curriculum (31%)**, which implies that teachers find the curriculum structure mostly adequate but may need more support in delivering it effectively.

The results suggest a strong demand for **practical, resource-based, and technology-supported training** rather than solely theoretical improvements. Teachers prioritize **hands-on experience and the use of teaching aids**, which indicates that current training programs may rely too

heavily on lectures and lack interactive, applied components. The fact that **technology integration is a key concern** suggests that many educators either lack access to digital tools or require additional training to effectively incorporate them into their teaching. Furthermore, the emphasis on **pedagogical skills and science process skills** indicates a need for improved instructional methods that go beyond content delivery to actively engage students in inquiry-based learning. While **content knowledge remains an important factor**, it is not as urgent as the need for hands-on and interactive teaching approaches. The relatively lower priority given to **assessment and curriculum updates** implies that teachers are generally comfortable with these areas but struggle with their practical application in the classroom.

The findings indicate a significant need for **practical, resource-based, and technology-supported training** rather than purely theoretical instruction. The high percentage of responses for **hands-on experience, teaching aids/lab materials, and technology integration** suggests that teachers struggle with implementing practical applications in their classrooms. This may be due to a lack of access to resources, inadequate training, or a focus on traditional lecture-based methods rather than interactive learning. The emphasis on **pedagogical skills and science process skills** highlights the importance of improving teaching methodologies. Teachers require support in shifting from conventional teaching to more **inquiry-based and student-centered approaches**, which foster critical thinking and problem-solving. The concern around **content knowledge** suggests that while teachers have a foundational understanding of science concepts, they may need deeper expertise to teach more effectively. Interestingly, **science assessment and curriculum development** were identified as lower-priority areas for improvement. This suggests that while teachers recognize the importance of evaluating student learning and structuring the curriculum, they may feel more confident in these aspects compared to practical teaching methods. However, this does not mean that these areas are unimportant—rather, it indicates that **the immediate need lies in applying knowledge effectively rather than restructuring content.**

Teachers' CPD Practices
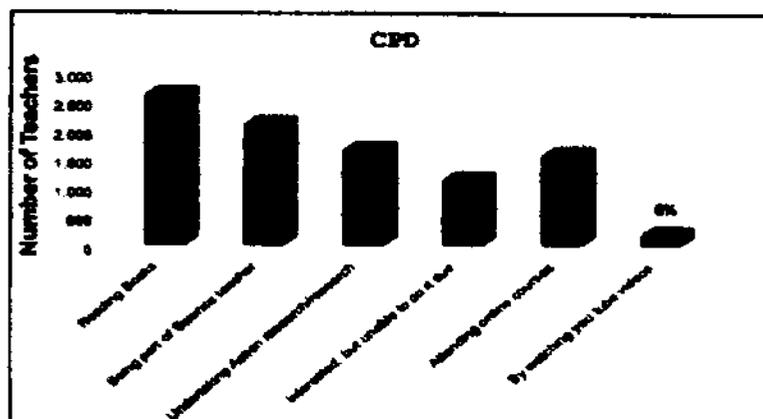
The most common approach to **Continuous Professional Development (CPD)** among teachers is **reading books (79%)**, indicating that a majority prefer self-directed learning through traditional resources. The second most popular method is **being part of a science teacher community (64%)**, showing that teachers value peer interaction and collaborative learning. **Undertaking action research (50%)** is another significant CPD activity, highlighting that half of the respondents engage in reflective and research-based teaching improvements. However, time constraints seem to be a barrier for many, as **34% expressed interest in CPD but are unable to participate due to lack of time. Attending online courses (48%)** is a preferred method for nearly half of the teachers, indicating a shift towards digital learning opportunities. In contrast, **watching YouTube videos (6%)** is the least utilized CPD method, suggesting that teachers do not rely on informal video content as a primary source of professional development.

The findings suggest that teachers favor **self-paced and structured learning methods** over informal or unstructured CPD opportunities. The high percentage of teachers reading books and being part of professional communities reflects a strong inclination towards **deep learning and peer-based collaboration** rather than quick, easily accessible online content. The significant engagement in **action research (50%)** indicates that many teachers are committed to improving their practices through inquiry-based methods. However, the fact that **34% of respondents cite time constraints as a barrier** suggests that many teachers are interested in CPD but struggle to find time amidst their teaching responsibilities. The preference for **online courses (48%)** suggests that teachers are open to digital learning but may need more guidance on effective platforms and resources. The low reliance on **YouTube videos (6%)** indicates that teachers may not perceive freely available video content as credible or structured enough for meaningful CPD.

The data highlights the **importance of self-directed and collaborative learning** in teachers' professional growth. The dominance of **reading books and being part of professional communities** suggests that teachers prefer structured and reliable sources of knowledge over informal learning methods. However, the **time constraints faced by 34% of teachers** indicate that CPD programs need to be **flexible and accessible** to accommodate their busy schedules. The moderate interest in **online courses (48%)** shows potential for digital CPD initiatives, but proper support and awareness are needed to encourage greater participation. Finally, the **low engagement with YouTube videos (6%)** suggests that while digital learning is growing, teachers may prefer well-organized platforms over freely available, unstructured content. This insight can be used to design CPD programs that integrate **formalized online training with collaborative learning communities**, ensuring that teachers receive both structured content and peer support in their professional growth.

Support requirements for science teaching
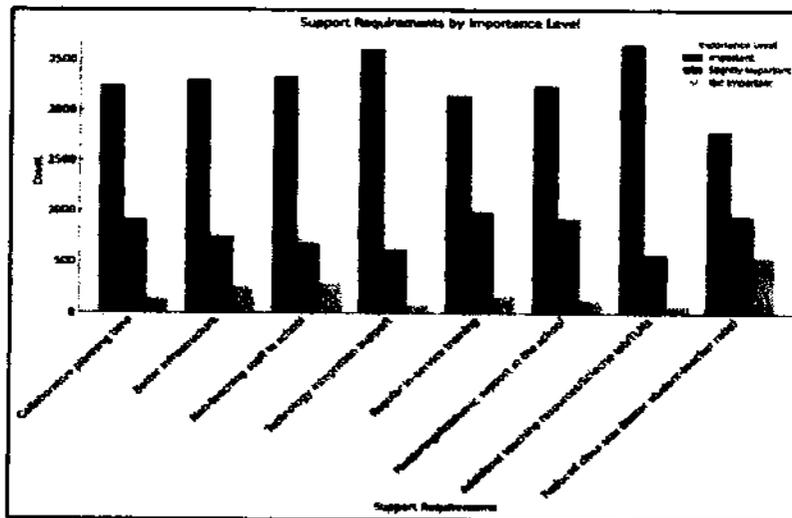
The chart illustrates the importance levels of various support requirements in schools, categorized as "Important," "Slightly Important," and "Not Important." A dominant trend in the chart is that most support requirements are perceived as highly important, as shown by the prevalence of dark purple bars. This suggests that schools recognize significant gaps in infrastructure, staff, and academic support, which require urgent intervention.

Among the most highly rated needs are **regular in-service training, technology integration support, and mentoring/academic support in schools**, which have the highest counts under the "Important" category. This indicates that teachers and school staff see continuous professional development and digital integration as crucial for improving teaching effectiveness. Schools may require ongoing training programs to keep up with modern pedagogical methods and technology-driven education.

Collaborative planning time and better infrastructure are also seen as essential, highlighting the necessity of improved working conditions for teachers. Adequate planning time allows educators to coordinate lessons effectively, and enhanced infrastructure supports a conducive learning environment. Similarly, **non-teaching staff in schools** is deemed important, signifying the need for administrative and operational assistance to reduce teachers' non-instructional workload.

Interestingly, while most support requirements are rated as important, some areas such as **reduced class sizes** and **additional teaching resources/science labs/TLMs** have a slightly higher proportion of responses labeling them as "Slightly Important" or "Not Important." This could indicate that while these aspects are beneficial, they are not seen as immediate priorities compared to more pressing concerns like training and technology integration.

Overall, the chart underscores the urgent need for investments in teacher development, infrastructure, and technology integration in schools. Addressing these support requirements would enhance teacher effectiveness and overall student learning outcomes. Education policymakers and administrators should prioritize these needs when formulating improvement strategies.

Teachers' recommendations for training programs
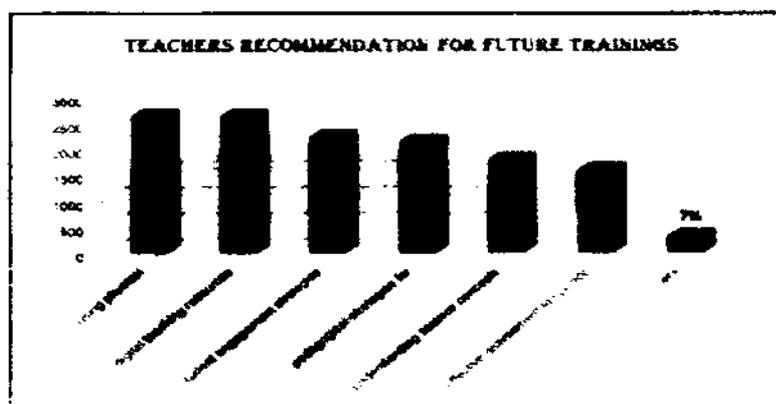
The chart presents teachers' recommendations for future training, highlighting key areas where they seek professional development. The most frequently suggested areas for training are **using physical teaching resources** and **digital teaching resources**, both receiving the highest number of responses. This suggests that educators recognize the need to improve their skills in utilizing both traditional and modern tools to enhance classroom instruction. The emphasis on digital resources also indicates a growing shift towards technology-integrated teaching, which aligns with modern educational trends.

Student engagement strategies and **pedagogical strategies** follow closely in importance. This implies that teachers are seeking effective methods to maintain student interest and improve learning outcomes. Engaging students actively in lessons is a critical component of effective teaching, and the demand for training in this area suggests that educators are looking for innovative ways to keep students motivated and involved.

Training on **understanding science concepts** and **effective assessment in science** also appears to be of significant interest, though slightly lower in priority compared to other topics. This suggests that teachers see a need for deeper content knowledge and improved assessment techniques to better evaluate student understanding and progress, particularly in science subjects.

The **"Others"** category received the least responses, indicating that the majority of training needs fall within the predefined categories. This suggests that teachers have clear and specific areas they want to focus on, rather than highly individualized training preferences.

Overall, the chart indicates that teachers are prioritizing training that enhances both their instructional methods and their ability to effectively utilize teaching resources. Professional development programs should therefore focus on blended learning approaches, integrating digital and physical teaching tools, and equipping teachers with strategies to improve student engagement and assessment. Addressing these needs will contribute to better teaching effectiveness and improved student learning experiences.

Teachers Choice for topics for Future training programs

Teachers' choice of topics for workshops
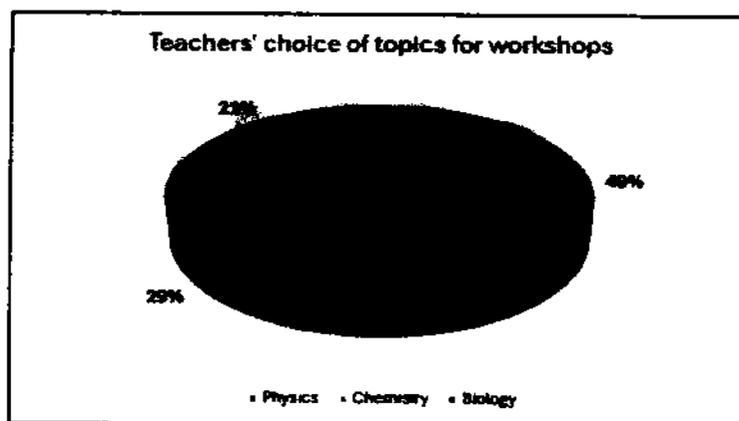
- Topics that are typically a part of "Physics" section appear to be the most preferred topic, chosen by 49% of teachers, indicating a significant interest in enhancing pedagogical or conceptual understanding in this subject.
- Topics in Chemistry follow with 29%, showing a moderate preference among educators.
- Topics in Biology account for 21% of teacher preferences, reflecting a steady interest in professional development in this area.

These findings indicate a strong demand for professional development in Physics, which could be attributed to its conceptual complexity or evolving pedagogical methods. Understanding these preferences can help in designing targeted teacher training programs that align with their needs.

Key findings from Teacher Interview data on Suggestions for Future training workshops

- Approximately 20% of teachers have reported that they have not attended nay trainings The most common training programs teachers report to be attended are DIIKSHA, Marusinchana, Cluster Meetings, IISC training, Induction Training, Agastya Foundation Training, Foundation training, PAB, TALP, NISHTA, Kalika Chetarike
- **Practical, Hands-on Learning (87 out of responses)** – The most highly recommended training type, showing that teachers prefer **interactive and experiential learning** to enhance student engagement.

- **Technology-Oriented Sessions (60 out of 131 responses)** – A significant demand for **digital tools and modern technology** in teaching, indicating a need for better **integration of technology** in classrooms.
- **Early and Well-Structured Training Schedules (37 out of 131 responses)** – Teachers value **properly planned and scheduled** training sessions to ensure effective participation.
- **Expert-Led Training (28 out of 131 responses)** – There is a preference for **training conducted by specialists** who provide deeper insights and expertise.
- **Content Enrichment Training (17 out of 131 responses)** – Some teachers require **advanced subject knowledge** to improve their teaching content.
- **Training on Pedagogical Knowledge (19 out of 131 responses)** – Indicates a need for **better teaching strategies** and classroom management techniques.
- **Curriculum-Based Training (11 out of 131 responses)** – A small portion prefers training aligned directly with **curriculum guidelines and standards.**
- **Others (22 out of 131 responses)** – This category suggests additional preferences, possibly including **context-specific training or flexible learning approaches.**

4.6.1 Analysis and Interpretation

- The high demand for **hands-on and technology-oriented training** suggests that teachers recognize the importance of **interactive and digital learning tools** in modern education.
- The preference for **structured and expert-led sessions** indicates that teachers seek **well-organized and high-quality professional development** experiences.
- The relatively lower emphasis on **curriculum-based training** shows that teachers may value **practical teaching skills** over rigid syllabus-focused instruction.
- The **diverse training needs** reflect the importance of offering **customized professional development** to cater to different teaching styles and challenges.

4.6.2 Key findings from FGD Discussion about Training Programs

- Capacity building workshops for science are usually less than the other subjects.
- Teachers believed scheduling the workshops at the beginning of the academic year would be more helpful in planning their classroom instruction process for the year.
- There is a discrepancy between the subjects that the teachers are appointed to teach and the subjects they teach in the school. Also, it would be more appropriate for the teachers to participate in a capacity building program of the subject they teach.
- The sessions in the workshops should focus more on content enrichment, establishing real life connections, along with appropriate pedagogical approaches.

- When discussing the implementation of workshop learnings in the classroom, teachers highlighted both their areas of interest in professional development and the types of activities they found practical for classroom instruction.
- Firstly, teachers expressed a strong preference for workshops that focus on hands-on, activity-based learning, innovative teaching strategies, and subject-specific advancements. Additionally, educators showed enthusiasm for training sessions that integrate technology in science education, experimental demonstrations, and interdisciplinary approaches that bridge multiple scientific disciplines.
- Secondly, when reflecting on classroom implementation, teachers emphasized activities that were both novel and feasible, particularly those that provided interactive and inquiry-driven learning experiences. Concepts involving simple physics experiments, chemical reactions with easily accessible materials, and biological models that encourage student participation were frequently mentioned as effective tools for engagement. Educators appreciated activities that required minimal resources yet significantly enhanced conceptual understanding, enabling them to seamlessly incorporate workshop learnings into their daily teaching practices.

Chapter - 5 RECOMMENDATIONS AND SUGGESTIONS

The recommendations emerging from this study have been organized into four thematic groups. This categorization reflects the key areas where teachers expressed challenges and aspirations, and where systemic responses are most urgently needed. By grouping recommendations thematically, we aim to provide a coherent and actionable framework for stakeholders—teacher educators, school leaders, and policymakers.

This structure also aligns with the diverse nature of teacher needs: while some seek conceptual clarity and pedagogical support, others face structural or logistical barriers such as workload and lack of resources. The recommendations are therefore designed not just to offer generic solutions but to **reconcile systemic gaps with teacher realities**, making science teaching more feasible, meaningful, and empowering at the classroom level. Grouping them helps emphasize that progress in science education requires **a blend of instructional innovation, practical support, continuous professional development, and system-level infrastructure.**

Teacher Professional Development & Beliefs

This category addresses the importance of shaping teachers' understanding of science and learning. It focuses on refining pedagogical beliefs, promoting reflective practice, and strengthening pre-service and in-service training to support inquiry-based, evolving views of science.

- Professional development programs should be designed to help teachers reconcile their personal beliefs about science with inquiry-based teaching practices.
- Teachers should be supported to view experimentation not just as a way to confirm facts but as a means to explore and refine scientific understanding.
- Modules and workshops should include examples from the history of science to show how unexpected results and paradigm shifts have driven scientific progress.
- Opportunities should be created for reflective dialogue among teachers to explore how their beliefs influence their classroom choices.
- Pre-service teacher education should emphasize the evolving and tentative nature of scientific knowledge.
- History and philosophy of science courses should be integrated into teacher training to counter common misconceptions.
- Veteran teachers should receive targeted professional development that introduces them to recent advances in science and shifts in scientific thinking.
- Mid-career teachers should be supported through periodic curriculum updates and associated training.
- Textbooks and teaching materials should explicitly highlight that scientific theories evolve over time in response to new evidence.
- Teachers should be encouraged to join or form Professional Learning Communities (PLCs) to share ideas and mentor one another.

- Academic mentoring and feedback loops should be strengthened through regular classroom observations by CRPs, BRPs, and DIET faculty.
- Short, structured professional development sessions should be embedded into school hours to ensure continuous but manageable growth.

Instructional Practices & Classroom Pedagogy

This group focuses on improving the day-to-day classroom experience. It addresses the need for inquiry-based methods, multimodal teaching strategies, and greater student engagement through experimentation and visual learning.

- While planning remains a key factor for effective classroom instruction, it is essential to include sufficient time in the timetable for science teaching. Having a dedicated period, at least once a week for laboratory usage, especially in high school, shall help in providing the students an experience at experimentation.
- Training programs should help teachers plan and implement inquiry-based learning, emphasizing active science process skills.
- Teachers should be equipped to use a variety of instructional strategies, especially visual tools, to aid student understanding and retention.
- Use of digital simulations, animations, and multimedia resources should be promoted as effective ways to teach abstract concepts.
- Peer teaching models and student-led learning routines should be encouraged to increase student agency and reduce teacher burden.
- Teachers should be supported in using multiple representations of concepts—such as models, diagrams, and analogies—to foster scientific literacy.
- Locally available materials and low-cost science kits should be used to make learning more experiential and grounded in students' environments.
- Teacher training should address how to navigate the dual challenge of fostering deep conceptual learning while preparing students for exams.

Workload, Time, and Multigrade Support

This category responds to the structural and logistical constraints that teachers face—especially in multigrade settings or rural schools. It includes strategies for reducing non-teaching burdens and optimizing teacher time through planning tools and collaboration.

- Conduct time audits in schools to understand how teachers spend their time and identify ways to improve time use.
- Hire administrative support staff or simplify school tasks so that teachers can focus more on teaching and less on clerical work.
- Develop micro-planning templates tailored for multigrade settings to help teachers structure their lessons more effectively.

- Create cluster-based programs that provide peer support and pedagogical resources to teachers working in multigrade or time-constrained environments.
- Introduce peer teaching or student-led learning routines to optimize classroom time and foster collaborative learning.
- Dedicate time within the school schedule for collaborative lesson planning among teachers to reduce duplication and enhance coherence.
- Encourage local education authorities to enable and coordinate resource-sharing between nearby schools to optimize scarce resources.

Resources, Infrastructure, and Assessment

This group includes recommendations to improve material conditions for science teaching, such as availability of teaching aids, digital tools, and robust assessment practices. It highlights the importance of feedback, diagnostics, and hands-on learning.

- Invest in digital tools and physical resources to support science education, particularly in rural and under-resourced schools.
- Ensure reliable access to digital infrastructure like internet connectivity and platforms such as DIKSHA.
- Provide teachers with training on how to meaningfully integrate digital tools into their science lessons.
- Emphasize the use of low-cost teaching aids such as models, charts, and science kits to promote interactive and hands-on learning.
- Train teachers in diverse assessment strategies—such as project-based learning and open-ended questions—to move beyond rote evaluation.
- Conduct workshops on giving constructive and meaningful feedback that can guide student thinking.
- Offer targeted training to help teachers diagnose and address student misconceptions using evidence-based practices.
- Develop outreach efforts and parent engagement programs to increase family involvement in student learning, especially in science subjects.

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APPENDICES