



TEACHER EDUCATION @ 2030

Editors

Dr.K.H.Yadav, Offg. Principal

Dr.G.S.Patel, Research Cell Coordinator



Published by

A.G.TEACHERS COLLEGE

(Autonomous)

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Preface

The modern classroom is evolving rapidly, with students from Gen Z and Gen Alpha bringing new expectations, challenges, and learning styles. Being digital natives, these generations are accustomed to instant access to information, personalized learning experiences, and interactive engagement. The traditional role of teachers as sole knowledge providers has shifted to facilitators, mentors, and even tech-savvy guides navigating complex social and digital complexities. In this scenario, the critical question arises: Are teacher education colleges adequately preparing educators to meet the needs of these students?

Many teacher training programs still focus heavily on conventional pedagogy, emphasizing rote memorization and standardized assessments. While these methods have their place, they fall short in addressing the dynamic needs of modern students. Gen Z and Gen Alpha learners thrive on experiential learning, problem-solving, and digital integration. They prefer collaborative environments and expect their teachers to be technologically fluent, capable of using AI, virtual reality, and active learning techniques effectively. Beyond technology, educators must also be prepared to handle the emotional and psychological aspects of teaching.

To bridge the gap, teacher education colleges must rethink their curriculum. First, programs should incorporate more hands-on teaching experiences with real-world classroom exposure. Second, interdisciplinary training is essential—combining technology, psychology, sociology, and pedagogy to ensure holistic teacher preparation. Third, continuous professional development should be encouraged, where educators remain updated on emerging trends through workshops, certifications, and immersive experiences. Finally, institutions must embrace adaptive learning methods, where teachers-in-training use AI-driven education tools themselves, gaining firsthand experience in the systems they'll soon implement in their classrooms.

The future of education lies in adaptability. A well-prepared teacher today is not just an instructor but a guide, a collaborator, and an innovator. By rethinking teacher education, colleges can ensure that educators are equipped not only to teach but to inspire and empower the next generations in an ever-evolving learning environment.

This book is a humble effort to see through the mindsets and practices leading to enhanced teacher education program. Small steps can lead to giant leaps and outcome can

be realisation of vision forecasted in NEP 2020. This learning resource is the essence of efforts by various stakeholders.

This book would not have been possible without the unwavering support of Ahmedabad Education Society, Teaching staff and Admin staff of the college. I deeply appreciate the time, effort, and passion authors have poured into creating the chapter. I take this opportunity to express my gratitude towards the editorial team Dr. S.S.Shukla, Retd. Professor, Gujarat University, Dr.S.L.Solanki, Asso. Professor, A G Teachers College, Dr Elvina Pereira, Associate Prof. Xaviers College of Education, Mumbai, Dr. Hamish Juma, HoD, TUSOME, Tanzania, Dr. G S Patel, Asst. Professor, A G Teachers College for their insights which helped us in upscaling the quality.

As you turn these pages, my hope is that you find knowledge, inspiration, or perhaps even a new way of looking to Teacher Education.

With Gratitude,

Dr. Kaushal Yadav

Principal (offg)

A G Teachers College-Autonomous

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ART ANOVA (Aligned Rank Transform ANOVA)

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Abstract

This paper demonstrates the step-by-step application of ART ANOVA using a 2×3 factorial design with two independent variables (IVs): Method of Learning (CAI vs. CPLM) and School Area (Urban, Rural, Semi-Urban), and a dependent variable (DV) measuring student achievement. The process involves: Aligning data separately for each IV and interaction effect, Ranking the aligned data to convert it into ordinal form, Performing parametric ANOVA on the ranked data for each effect, Compiling results into a final ART ANOVA summary table.

Key findings indicate significant main effects for both Method ($p = 0.005$) and Area ($p = 0.002$), as well as a highly significant interaction effect ($p < 0.001$). The results suggest that ART ANOVA is a robust method for analyzing non-parametric data in multi factorial designs while maintaining interpretability similar to traditional ANOVA.

Keywords: ART ANOVA, factorial design, multifactor, Interaction effects, Ordinal data analysis

If data are obtained in interval or ratio scale and all the assumptions of parametric test are fulfilled, then, to check the main and interaction effects of two or more Independent Variables (IVs) on Dependent Variable (DV), two-way or multi-way ANOVA is used. One way ANOVA is used to check the effect of only one IV on DV in such situation. But, if the assumptions of parametric test are not fulfilled then Kruskal Wallis Test or Friedman Test is used instead of one-way ANOVA for testing the hypothesis. Both these tests are non-parametric and can be used only if the data are obtained in ordinal scale or converted in it. Friedman test is used only if the repeated measures of the same subjects of study are taken. In the same way, when data are obtained in ordinal scale (Ranks) or assumptions of parametric test are not fulfilled, Aligned Rank Transform Analysis of Variance (ART ANOVA) is used to check the main and interaction effects of two or more IVs on DV. Let's discuss how it happens.

CONCEPT OF ART ANOVA

It is a non-parametric test of testing hypotheses that is used to check the main and interaction effects of two or more IVs on a DV. It analyses ranked (ordinal) data. When any of the assumptions out of normality of data or homogeneity of the variances among the groups is violated or data are obtained in ordinal scale, then it is used to perform two way or multi way ANOVA. Data obtained in interval or ratio scale are converted in aligned data to use it. The data for each effect (main or interaction) must be aligned before ranks are calculated. It

requires IVs in nominal scale only. But the most important thing in terms of this test is that the parametric ANOVA is applied after ranking the aligned data. For that, separate ANOVA is done for each of the main effects and interaction effects and summary of ANOVA is prepared at the end.

PROCESS OF ART ANOVA

Let us understand the process of ART ANOVA with the help of an example. Here in Table 1, data are given in 2×2 factorial design.

As shown in Table 1, two IVs (1) Method of learning and (2) Area of the school are there in this

example. Area is given in columns and Method is shown in Rows. One school from each area and 20 students from each school are selected for the study. Two groups, each of 10 students, are there in each school. Both groups are given task to learn a particular unit of English grammar by different methods. Method of learning has two levels like Computer Assisted Learning (CAI) and Computerised Programmed Learning Material (CPLM). Method is labelled as (A) and its levels CAI and CPLM are labelled as (A_1) and (A_2) respectively. In the same way, Area of the school is labelled as (B) and its levels Urban, Rural and Semi Urban (Semi U) are labelled as (B_1), (B_2) and (B_3) respectively.

Based on this example, calculations for 2×2 ART ANOVA is done by following the steps as follows.

Step 1: Means at the Levels of IVs

First, the means for different groups are calculated by applying formula of mean ($\bar{x} = \frac{\sum x_i}{n}$) as shown in Table 2. (Here, calculations of the means are

Table 1			
Scores of the Students in Achievement Test			
Method (A)	Area (B)		
	Urban (B_1)	Rural (B_2)	SemiU (B_3)
CAI	25	12	21
(A_1)	24	18	23
	23	17	24
	21	16	26
	18	19	25
	17	20	28
	14	12	21
	15	14	26
	16	16	24
	12	15	24
CPLM	15	21	13
(A_2)	13	24	15
	14	25	17
	16	26	13
	17	23	18
	12	21	14
	13	24	15
	14	26	13
	15	23	14
	14	21	13

Table 2				
Means at Different Levels of IVs				
Method (A)	Area (B)			$\bar{X}$ of Method (A)
	Urban (B_1)	Rural (B_2)	Semi U (B_3)	
CAI	25	12	21	$\bar{x}_{A_1} = 19.53$
(A_1)	24	18	23	
	23	17	24	
	21	16	26	
	18	19	25	
	17	20	28	
	14	12	21	
	15	14	26	
	16	16	24	
	12	15	24	$\bar{x}_{A_2} = 17.4$
CPLM	15	21	13	
(A_2)	13	24	15	
	14	25	17	
	16	26	13	
	17	23	18	
	12	21	14	
	13	24	15	
	14	26	13	
	15	23	14	$\bar{X}_B$
	14	21	13	
	13	24	15	
$\bar{x}_{A_1B}$	$\bar{x}_{A_1B_1} = 18.5$	$\bar{x}_{A_1B_2} = 15.9$	$\bar{x}_{A_1B_3} = 24.2$	
$\bar{x}_{A_2B}$	$\bar{x}_{A_2B_1} = 14.3$	$\bar{x}_{A_2B_2} = 23.4$	$\bar{x}_{A_2B_3} = 14.5$	
$\bar{X}_B$	16.4	19.65	19.35	
	$\bar{x}_{B_1}$	$\bar{x}_{B_2}$	$\bar{x}_{B_3}$	$\bar{x}_{AB}$

not shown.)

The following mean scores are shown in the table.

- $\bar{x}_{A_1}$ = Mean score of CAI (A_1) method group = 19.53
- $\bar{x}_{A_2}$ = Mean score of CPLM (A_2) method group = 17.4
- $\bar{x}_{A_1B_1}$ = Mean score of CAI (A_1) method group of Urban (B_1) area = 18.5
- $\bar{x}_{A_1B_2}$ = Mean score of CAI (A_1) method group of Rural (B_2) area = 15.9
- $\bar{x}_{A_1B_3}$ = Mean score of CAI (A_1) method group of Semi Urban (B_3) area = 24.2
- $\bar{x}_{A_2B_1}$ = Mean score of CPLM (A_2) method group of Urban (B_1) area = 14.3
- $\bar{x}_{A_2B_2}$ = Mean score of CPLM (A_2) method group of Rural (B_2) area = 23.4
- $\bar{x}_{A_2B_3}$ = Mean score of CPLM (A_2) method group of Semi Urban (B_3) area = 14.5
- $\bar{x}_{B_1}$ = Mean score of Urban (B_1) area = 14.3
- $\bar{x}_{B_2}$ = Mean score of Rural (B_2) area = 23.4
- $\bar{x}_{B_3}$ = Mean score of Semi Urban (B_3) area = 14.5
- $\bar{x}_{AB}$ = Mean score of entire data = 18.467

Step 2: Aligned Data

Now data are aligned for each IV and interaction of IVs separately on the basis of respective means. Two IVs and one Interaction are there in this example. So data are aligned for each of them as follows.

Aligned Data for First IV

The first IV is Method and it has two levels. So, for each level data are aligned separately as follows.

Aligned Data of First Level of First IV. First level of the first IV (Method) is CAI. Total 30 observations are there in the group of CAI method, which are divided in three areas. There are 10 observations (raw scores) in each area of CAI group. Aligned score for each area of CAI group is found separately as follows.

Aligned Data of A_1B_1 Group. Total 10 observations are there in the group of CAI method of Urban Area that is called A_1B_1 Group. Aligned score of each of the observations of this group is found by applying *Formula 1*.

$$x'_{A_1B_1} = x_{A_1B_1} + \bar{x}_{A_1} - \bar{x}_{A_1B_1} - \bar{x}_{AB} \quad (1)$$

Where

- $x'_{A_1B_1}$ = Aligned score of raw score $x_{A_1B_1}$ in the context of CAI method
- $x_{A_1B_1}$ = Single row score of CAI method of Urban Area

The first raw score ($x_{A_1B_1}$) in A_1B_1 Group is 25. Its aligned score is found by replacing required values in *Formula 1* as follows.

$$x'_{A_1B_1} \text{ of } 25 = 25 + 19.53 - 18.5 - 18.467 = 7.567$$

(Here, the calculation is done through computer programme, so there may be difference in the number after decimal point.)

In this way, aligned score of each raw score of A_1B_1 group is found and placed in the cells of the table as shown in *Table 3*.

Table 3			
<i>Aligned Data of Method (A)</i>			
Method (A)	Area (B)		
	Urban (B ₁)	Rural (B ₂)	Semi U (B ₃)
CAI	7.566667	-2.83333	-2.13333
(A ₁)	6.566667	3.166667	-0.13333
	5.566667	2.166667	0.866667
	3.566667	1.166667	2.866667
	0.566667	4.166667	1.866667
	-0.43333	5.166667	4.866667
	-3.43333	-2.83333	-2.13333
	-2.43333	-0.83333	2.866667
	-1.43333	1.166667	0.866667
	-5.43333	0.166667	0.866667
CPLM	-0.36667	-3.46667	-2.56667
	-2.36667	-0.46667	-0.56667
	-1.36667	0.533333	1.433333
	0.633333	1.533333	-2.56667
	1.633333	-1.46667	2.433333
	-3.36667	-3.46667	-1.56667
	-2.36667	-0.46667	-0.56667
	-1.36667	1.533333	-2.56667
	-0.36667	-1.46667	-1.56667
	-1.36667	-3.46667	-2.56667

Aligned Data of A₁B₂ Group. Total 10 observations are there in the group of CAI method of Rural Area that is called A₁B₂ Group. Aligned score of each of the observations of this group is found by applying *Formula 2*.

$$x'_{A_1B_2} = x_{A_1B_2} + \bar{x}_{A_1} - \bar{x}_{A_1B_2} - \bar{x}_{AB..} \quad (2)$$

Where

- $x'_{A_1B_2}$ = Aligned score of raw score $x_{A_1B_2}$ in the context of CAI method
- $x_{A_1B_2}$ = Single row score of CAI method of Rural Area

The first raw score ($x_{A_1B_2}$) in A₁B₂ Group is 12. Its aligned score is found by replacing required values in *Formula 2* as follows.

$$x'_{A_1B_2} \text{ of } 12 = 12 + 19.53 - 18.5 - 18.467 = -2.833$$

In this way, aligned score of each raw score of A₁B₂ group is found and placed in the cells of the table as shown in *Table 3*.

Aligned Data of A₁B₃ Group. Total 10 observations are there in the group of CAI method of Semi Urban Area that is called A₁B₃ Group. Aligned score of each of the observations of this group is found by applying *Formula 3*.

$$x'_{A_1B_3} = x_{A_1B_3} + \bar{x}_{A_1} - \bar{x}_{A_1B_3} - \bar{x}_{AB..} \quad (3)$$

Where

- $x'_{A_1B_3}$ = Aligned score of raw score $x_{A_1B_3}$ in the context of CAI method
- $x_{A_1B_3}$ = Single raw score of CAI method of Semi Urban Area

The first raw score ($x_{A_1B_3}$) in A_1B_3 Group is 21. Its aligned score is found by replacing required values in *Formula 3* as follows.

$$x'_{A_1B_3} \text{ of } 21 = 21 + 19.53 - 24.2 - 18.467 = -2.1333$$

In this way, aligned score of each raw score of A_1B_3 group is found and placed in the cells of the table as shown in *Table 3*.

Aligned Data of Second Level of First IV. Second level of the first IV (Method) is CPLM. Total 30 observations are there in the group of CPLM method, which are divided in three areas. There are 10 observations (raw scores) in each area of CPLM group. Aligned score for each area of this group is found separately as follows.

Aligned Data of A_2B_1 Group. Total 10 observations are there in the group of CPLM method of Urban Area that is called A_2B_1 Group. Aligned score of each of the observations of this group is found by applying *Formula 4*.

$$x'_{A_2B_1} = x_{A_2B_1} + \bar{x}_{A_2} - \bar{x}_{A_2B_1} - \bar{x}_{AB} \dots (4)$$

Where

- $x'_{A_2B_1}$ = Aligned score of raw score $x_{A_2B_1}$ in the context of CPLM method
- $x_{A_2B_1}$ = Single raw score of CPLM method of Urban Area

The first raw score in A_2B_1 Group is 15. Its aligned score is found by replacing required values in *Formula 4* as follows.

$$x'_{A_2B_1} \text{ of } 15 = 15 + 17.4 - 14.3 - 18.467 = -0.36667$$

In this way, aligned score of each raw score of A_2B_1 group is found and placed in the cells of the table as shown in *Table 3*.

Aligned Data of A_2B_2 Group. Total 10 observations are there in the group of CPLM method of Rural Area that is called A_2B_2 Group. Aligned score of each of the observations of this group is found by applying *Formula 5*.

$$x'_{A_2B_2} = x_{A_2B_2} + \bar{x}_{A_2} - \bar{x}_{A_2B_2} - \bar{x}_{AB} \dots (5)$$

Where

- $x'_{A_2B_2}$ = Aligned score of raw score $x_{A_2B_2}$ in the context of CPLM method
- $x_{A_2B_2}$ = Single raw score of CPLM method of Rural Area

The first raw score in A_2B_2 Group is 21. Its aligned score is found by replacing required values in *Formula 5* as follows.

$$x'_{A_2B_2} \text{ of } 21 = 21 + 19.53 - 23.4 - 18.467 = -3.46667$$

In this way, aligned score of each raw score of A_2B_2 group is found and placed in the cells of the table as shown in *Table 3*.

Aligned Data of A_2B_3 Group. Total 10 observations are there in the group of CPLM method of Semi Urban Area that is called A_2B_3 Group. Aligned score of each of the observations of this group is found by applying *Formula 6*.

$$x'_{A_2B_3} = x_{A_2B_3} + \bar{x}_{A_2} - \bar{x}_{A_2B_3} - \bar{x}_{AB} \dots (6)$$

Where

- $x'_{A_2B_3}$ = Aligned score of raw score $x_{A_2B_3}$ in the context of CPLM method
- $x_{A_2B_3}$ = Single raw score of CPLM method of Semi Urban Area

The first raw score in A_2B_3 Group is 13. Its aligned score is found by replacing required values in *Formula 6* as follows.

$$\begin{aligned} x'_{A_2B_3} \text{ of } 13 &= 13 + 19.53 - 14.5 - 18.467 \\ &= -2.56667 \end{aligned}$$

In this way, aligned score of each raw score of A_2B_3 group is found and placed in the cells of the table as shown in *Table 3*.

Aligned Data for Second IV

The second IV is Area and it has three levels. So, for each level data are aligned

separately as follows.

Aligned Data of First Level of Second IV. First level of the second IV (Area) is Urban. Total 20 observations are there in the group of Urban area, which are divided in two methods. There are 10 observations (raw scores) in each method that belongs to urban area. Aligned score for each method of Urban area is found separately as follows.

Aligned Data of A_1B_1 Group. Total 10 observations are there in the group of Urban Area of CAI method that is called A_1B_1 Group. Aligned score of each of the observations of this group is found by applying *Formula 7*.

$$x''_{A_1B_1} = x_{A_1B_1} + \bar{x}_{B_1} - \bar{x}_{A_1B_1} - \bar{x}_{AB} \quad (7)$$

Where

- $x''_{A_1B_1}$ = Aligned score of raw score $x_{A_1B_1}$ in the context of Urban area.
- $x_{A_1B_1}$ = Single raw score of Urban Area of CAI method.

The first raw score ($x_{A_1B_1}$) in A_1B_1 Group is 25. Its aligned score is found by replacing required values in *Formula 1* as follows.

$$x''_{A_1B_1} \text{ of } 25 = 25 + 16.4 - 18.5 - 18.467 = 4.433$$

In this way, aligned score of each raw score of A_1B_1 group is found and placed in the cells of the table as shown in *Table 4*.

Table 4			
<i>Aligned Data of Area (B)</i>			
Method (A)	Area (B)		
	Urban (B ₁)	Rural (B ₂)	Semi U (B ₃)
CAI	4.433333	-2.71667	-2.31667
(A ₁)	3.433333	3.283333	-0.31667
	2.433333	2.283333	0.683333
	0.433333	1.283333	2.683333
	-2.56667	4.283333	1.683333
	-3.56667	5.283333	4.683333
	-6.56667	-2.71667	-2.31667
	-5.56667	-0.71667	2.683333
	-4.56667	1.283333	0.683333
	-8.56667	0.283333	0.683333
CPLM	-1.36667	-1.21667	-0.61667
(A ₂)	-3.36667	1.783333	1.383333
	-2.36667	2.783333	3.383333
	-0.36667	3.783333	-0.61667
	0.633333	0.783333	4.383333
	-4.36667	-1.21667	0.383333
	-3.36667	1.783333	1.383333
	-2.36667	3.783333	-0.61667
	-1.36667	0.783333	0.383333
	-2.36667	-1.21667	-0.61667

Aligned Data of A_2B_1 Group. Total 10 observations are there in the group of Urban Area of CPLM method that is called A_2B_1 Group. Aligned score of each of the observations of this group is found by applying *Formula 8*.

$$x''_{A_2B_1} = x_{A_2B_1} + \bar{x}_{B_1} - \bar{x}_{A_2B_1} - \bar{x}_{AB} \quad (8)$$

Where

- $x''_{A_2B_1}$ = Aligned score of raw score $x_{A_2B_1}$ in the context of Urban area.
- $x_{A_2B_1}$ = Single row score of Urban Area of CPLM method.

The first raw score ($x_{A_2B_1}$) in A_2B_1 Group is 15. Its aligned score is found by replacing required values in *Formula 1* as follows.

$$x''_{A_2B_1} \text{ of } 25 = 15 + 16.4 - 14.3 - 18.467 = -1.3667$$

In this way, aligned score of each raw score of A_2B_1 group is found and placed in the cells of the table as shown in *Table 4*.

Aligned Data of A_1B_2 Group. Total 10 observations are there in the group of Rural Area of CAI method that is called A_1B_2 Group. Aligned score of each of the observations of this group is found by applying *Formula 9*.

$$x''_{A_1B_2} = x_{A_1B_2} + \bar{x}_{B_2} - \bar{x}_{A_1B_2} - \bar{x}_{AB} \quad (9)$$

Where

- $x''_{A_1B_2}$ = Aligned score of raw score $x_{A_1B_2}$ in the context of Rural area.
- $x_{A_1B_2}$ = Single row score of Rural Area of CAI method.

The first raw score ($x_{A_1B_2}$) in A_1B_2 Group is 12. Its aligned score is found by replacing required values in *Formula 9* as follows.

$$\begin{aligned} x''_{A_1B_2} \text{ of } 12 &= 12 + 19.65 - 15.9 - 18.467 \\ &= -2.717 \end{aligned}$$

In this way, aligned score of each raw score of A_1B_2 group is found and placed in the cells of the table as shown in *Table 4*.

Aligned Data of A_2B_2 Group. Total 10 observations are there in the group of Rural Area of CPLM method that is called A_2B_2 Group. Aligned score of each of the observations of this group is found by applying *Formula 10*.

$$x''_{A_2B_2} = x_{A_2B_2} + \bar{x}_{B_2} - \bar{x}_{A_2B_2} - \bar{x}_{AB} \quad (10)$$

Where

- $x''_{A_2B_2}$ = Aligned score of raw score $x_{A_2B_2}$ in the context of Rural area.
- $x_{A_2B_2}$ = Single row score of Rural Area of CPLM method.

The first raw score ($x_{A_2B_2}$) in A_2B_2 Group is 21. Its aligned score is found by replacing required values in *Formula 10* as follows.

$$\begin{aligned} x''_{A_2B_2} \text{ of } 21 &= 21 + 19.65 - 23.4 - 18.467 \\ &= -1.217 \end{aligned}$$

In this way, aligned score of each raw score of A_2B_2 group is found and placed in the cells of the table as shown in *Table 4*.

Aligned Data of A_1B_3 Group. Total 10 observations are there in the group of Semi Urban Area of CAI method that is called A_1B_3 Group. Aligned score of each of the observations of this group is found by applying *Formula 11*.

$$x''_{A_1B_3} = x_{A_1B_3} + \bar{x}_{B_3} - \bar{x}_{A_1B_3} - \bar{x}_{AB} \quad (11)$$

Where

- $x''_{A_1B_3}$ = Aligned score of raw score $x_{A_1B_3}$ in the context of Semi urban area.
- $x_{A_1B_3}$ = Single raw score of Semi urban Area of CAI method.

The first raw score ($x_{A_1B_3}$) in A_1B_3 Group is 21. Its aligned score is found by replacing required values in *Formula 11* as follows.

$$\begin{aligned} x''_{A_1B_3} \text{ of } 21 &= 21 + 19.35 - 24.2 - 18.467 \\ &= -2.317 \end{aligned}$$

In this way, aligned score of each raw score of A_1B_3 group is found and placed in the cells of the table as shown in *Table 4*.

Aligned Data of A_2B_3 Group. Total 10 observations are there in the group of Semi Urban Area of CPLM method that is called A_2B_3 Group. Aligned score of each of the observations of this group is found by applying *Formula 12*.

$$x''_{A_2B_3} = x_{A_2B_3} + \bar{x}_{B_3} - \bar{x}_{A_2B_3} - \bar{x}_{AB} \dots (12)$$

Where

- $x''_{A_2B_3}$ = Aligned score of raw score $x_{A_2B_3}$ in the context of Semi Urban area.
- $x_{A_2B_3}$ = Single raw score of Semi Urban Area of CPLM method.

The first raw score ($x_{A_2B_3}$) in A_2B_3 Group is 13. Its aligned score is found by replacing required values in *Formula 12* as follows.

$$\begin{aligned} x''_{A_2B_3} \text{ of } 13 &= 13 + 19.35 - 14.5 - 18.467 \\ &= -0.617 \end{aligned}$$

In this way, aligned score of each raw score of A_2B_2 group is found and placed in the cells of the table as shown in *Table 4*.

Aligned Data for Interaction between Two IVs [Method (A) $\times$ Area (B)]

Six groups of data are there for interaction between Method (A) $\times$ Area (B). Aligned data for each group are found separately as follows.

Aligned Data of First Group (A_1B_1) of Interaction between IVs ($A \times B$). Total 10 observations are there in first group that is A_1B_1 . Aligned score of each score of this group is found by applying *Formula 13*.

$$x'_{AB(A_1B_1)} = x_{A_1B_1} + \bar{x}_{AB} - \bar{x}_{A_1} - \bar{x}_{B_1} \dots (13)$$

Where

- $x'_{AB(A_1B_1)}$ = Aligned score of raw score $x_{A_1B_1}$ in the context of $A \times B$.
- $x_{A_1B_1}$ = Single raw score of CAI method $\times$ Urban area.

The first raw score ($x_{A_1B_1}$) in terms of $A \times B$ is 25. Its aligned score is found by replacing required values in *Formula 13* as follows.

$$\begin{aligned} x'_{AB(A_1B_1)} \text{ of } 25 &= 25 + 18.467 - 19.533 - 16.4 \\ &= 7.534 \end{aligned}$$

In this way, aligned score of each raw score of A_1B_1 group is found and placed in the cells of the table as shown in *Table 5*.

Aligned Data of Second Group (A_1B_2) of Interaction between IVs ($A \times B$). Total 10 observations are there in second group that is A_1B_2 . Aligned score of each score of this group is found by applying *Formula 14*.

$$x'_{AB(A_1B_2)} = x_{A_1B_2} + \bar{x}_{AB} - \bar{x}_{A_1} - \bar{x}_{B_2} \dots (14)$$

Where

- $x'_{AB(A_1B_2)}$ = Aligned score of raw score $x_{A_1B_2}$ in the context of $A \times B$.
- $x_{A_1B_2}$ = Single raw score of CAI method $\times$ Rural Area.

The first raw score ($x_{A_1B_2}$) in terms of $A \times B$ is 12. Its aligned score is found by replacing required values in *Formula 14* as follows.

$$\begin{aligned} x'_{AB(A_1B_2)} \text{ of } 12 &= 12 + 18.467 - 19.533 - 19.65 \\ &= -8.716 \end{aligned}$$

In this way, aligned score of each raw score of A_1B_2 group is found and placed in the cells of the table as shown in *Table 5*.

Aligned Data of Third Group (A_1B_3) of Interaction between IVs ($A \times B$). Total 10 observations are there in third group that is A_1B_3 . Aligned score of each raw score of this group is found by applying *Formula 15*.

$$x'_{AB(A_1B_3)} = x_{A_1B_3} + \bar{x}_{AB} - \bar{x}_{A_1} - \bar{x}_{B_3} \dots (15)$$

Where

- $x'_{AB (A_1B_3)}$ = Aligned score of raw score $x_{A_1B_3}$ in the context of A×B.
- $x_{A_1B_3}$ = Single row score of CAI method × Semi Urban Area.

The first raw score ($x_{A_1B_3}$) interms of A×B is 21. Its aligned score is found by replacing required values in *Formula 15* as follows.

$$\begin{aligned} x'_{AB (A_1B_3)} \text{ of } 21 &= 21 + 18.467 - 19.533 - 19.35 \\ &= 0.584 \end{aligned}$$

In this way, aligned score of each raw score of A_1B_3 group is found and placed in the cells of the table as shown in *Table 5*.

Aligned Data of Fourth Group (A_2B_1) of Interaction between IVs (A×B). Total 10 observations are there in fourth group that is A_2B_1 . Aligned score of each score of this group is found by applying *Formula 16*.

$$x'_{AB (A_2B_1)} = x_{A_2B_1} + \bar{x}_{AB} - \bar{x}_{A_2} - \bar{x}_{B_1} \dots (16)$$

Where

- $x'_{AB (A_2B_1)}$ = Aligned score of raw score $x_{A_2B_1}$ in the context of A×B.
- $x_{A_2B_1}$ = Single raw score of CPLMmethod × Urban area.

The first raw score ($x_{A_2B_1}$) interms of A×B is 15. Its aligned score is found by replacing required values in *Formula 16* as follows.

$$\begin{aligned} x'_{AB (A_2B_1)} \text{ of } 15 &= 15 + 18.467 - 17.4 - 16.4 \\ &= -0.333 \end{aligned}$$

In this way, aligned score of each raw score of A_2B_1 group is found and placed in the cells of the table as shown in *Table 5*.

Aligned Data of Fifth Group (A_2B_2) of Interaction between IVs (A×B). Total 10 observations are there in fifth group that is A_2B_2 . Aligned score of each score of this group is found by applying *Formula 17*.

$$x'_{AB (A_2B_2)} = x_{A_2B_2} + \bar{x}_{AB} - \bar{x}_{A_2} - \bar{x}_{B_2} \dots (17)$$

Where

- $x'_{AB (A_2B_2)}$ = Aligned score of raw score $x_{A_2B_2}$ in the context of A×B.
- $x_{A_2B_2}$ = Single row score of CPLM × Rural Area.

The first raw score ($x_{A_2B_2}$) interms of A×B is 21. Its aligned score is found by replacing required values in *Formula 17* as follows.

$$\begin{aligned} x'_{AB (A_2B_2)} \text{ of } 21 &= 21 + 18.467 - 17.4 - 19.65 \\ &= 2.417 \end{aligned}$$

In this way, aligned score of each raw score of A_2B_2 group is found and placed in the cells of the table as shown in *Table 5*.

Aligned Data of Sixth Group (A_2B_3) of Interaction between IVs (A×B). Total 10 observations are there in sixth group that is A_2B_3 . Aligned score of each raw score of this group is found by applying *Formula 18*.

$$x'_{AB (A_2B_3)} = x_{A_2B_3} + \bar{x}_{AB} - \bar{x}_{A_2} - \bar{x}_{B_3} \dots (18)$$

Where

- $x'_{AB (A_2B_3)}$ = Aligned score of raw score $x_{A_2B_3}$ in the context of A×B.
- $x_{A_2B_3}$ = Single row score of CPLM × Semi Urban Area.

The first raw score ($x_{A_2B_3}$) interms of A×B is 13. Its aligned score is found by replacing required values in *Formula 15* as follows.

$$\begin{aligned} x'_{AB (A_2B_3)} \text{ of } 13 &= 13 + 18.467 - 17.4 - 19.35 \\ &= -5.283 \end{aligned}$$

In this way, aligned score of each raw score of A_2B_3 group is found and placed in the

cells of the table as shown in *Table 5*.

Table 5 <i>Aligned Data of Method (A) × Area (B)</i>			
Method (A)	Area (B)		
	Urban (B ₁)	Rural (B ₂)	Semi U (B ₃)
CAI	7.533333	-8.71667	0.583333
(A ₁)	6.533333	-2.71667	2.583333
	5.533333	-3.71667	3.583333
	3.533333	-4.71667	5.583333
	0.533333	-1.71667	4.583333
	-0.46667	-0.71667	7.583333
	-3.46667	-8.71667	0.583333
	-2.46667	-6.71667	5.583333
	-1.46667	-4.71667	3.583333
	-5.46667	-5.71667	3.583333
CPLM	-0.33333	2.416667	-5.28333
(A ₂)	-2.33333	5.416667	-3.28333
	-1.33333	6.416667	-1.28333
	0.666667	7.416667	-5.28333
	1.666667	4.416667	-0.28333
	-3.33333	2.416667	-4.28333
	-2.33333	5.416667	-3.28333
	-1.33333	7.416667	-5.28333
	-0.33333	4.416667	-4.28333
	-1.33333	2.416667	-5.28333

Table 6 <i>Aligned Ranks of Method (A)</i>			
Method (A)	Area (B)		
	Urban (B ₁)	Rural (B ₂)	Semi U (B ₃)
CAI	60	7.5	16.5
(A ₁)	59	53	34
	58	49	40
	54	42.5	51.5
	37	55	48
	31	57	56
	5	7.5	16.5
	13	26	51.5
	22	42.5	40
	1	35	40
CPLM	32.5	3	10.5
(A ₂)	14.5	29.5	27.5
	24	36	44
	38	45.5	10.5
	47	20.5	50
	6	3	18.5
	14.5	29.5	27.5
	24	45.5	10.5
	32.5	20.5	18.5
	24	3	10.5

Step 3: Aligned Ranks

Now average ranks are given to aligned scores for each IV and interaction of IVs separately. Two IVs and one Interaction are there in this example. So, average ranks are given to the aligned scores for each of them as follows.

Average Ranks to Aligned Data of First IV [Method (A)]. Total 60 observations are there in the data. Aligned data for Method (A) are found in *Table 3*. All these aligned scores are now assigned common ranks by ignoring the groups. The smallest aligned score is given Rank 1 and the largest aligned score is given the highest rank. In this way, entire aligned data are converted in aligned ranks. Average ranks are given to the scores which are repeating. The ranks of entire data are written in the respective cells of respective groups as shown in *Table 6*.

Average Ranks to Aligned Data of Second IV [Area (B)]. Total 60 observations are there in the data. Aligned data for Area (B) are found in *Table 4*. All these aligned scores are now assigned common ranks by ignoring the groups. The smallest aligned score is given Rank 1 and the largest aligned score is given the highest rank. In this way, entire aligned data are converted in aligned ranks. Average ranks are given to the scores which are repeating. The ranks of entire data are written in the respective cells of respective groups as shown in *Table 7*.

Table 7			
<i>Aligned Ranks of Area (B)</i>			
Method (A)	Area (B)		
	Urban (B1)	Rural (B2)	Semi U (B3)
CAI	58	9.5	15.5
(A ₁)	53	51	28
	47	46	35
	32	39.5	48.5
	11	56	43
	6	60	59
	2	9.5	15.5
	3	22	48.5
	4	39.5	35
	1	29	35
CPLM	17.5	20	24.5
(A ₂)	7.5	44.5	41.5
	13	50	52
	27	54.5	24.5
	33	37.5	57
	5	20	30.5
	7.5	44.5	41.5
	13	54.5	24.5
	17.5	37.5	30.5
	13	20	24.5

Average Ranks to Aligned Data of Interaction between Method (A) × Area (B).

Total 60 observations are there in the data. Aligned data for interaction between Method (A) × Area (B) are given in Table 5. All these aligned scores are now assigned common ranks by ignoring the groups. The smallest aligned score is given Rank 1 and the largest aligned score is given the highest rank. In this way, entire aligned data are converted in aligned ranks. Average ranks are given to the scores which are repeating.

The ranks of entire data are written in the respective cells of respective groups as shown in Table 8.

Table 8*Aligned Ranks of Interaction between Method (A) × Area (B)*

Method (A)	Area (B)		
	Urban (B ₁)	Rural (B ₂)	Semi U (B ₃)
CAI	58	9.5	15.5
(A ₁)	53	51	28
	47	46	35
	32	39.5	48.5
	11	56	43
	6	60	59
	2	9.5	15.5
	3	22	48.5
	4	39.5	35
	1	29	35
CPLM	17.5	20	24.5
(A ₂)	7.5	44.5	41.5
	13	50	52
	27	54.5	24.5
	33	37.5	57
	5	20	30.5
	7.5	44.5	41.5
	13	54.5	24.5
	17.5	37.5	30.5
	13	20	24.5

Step4 : ANOVA for each IV and Interaction of IVs

Now, ANOVA is done for both IVs and Interaction of IVs separately based on aligned ranks. At this stage, parametric ANOVA is done. Two independent variables are there in our example, so two-way parametric ANOVA is done for each IV and interaction of IVs. ANOVA can be done manually or through MS Excel, SPSS or through Real Statistics Analysis tool pack.

ANOVA for Method (A).

Based on aligned ranks given in *Table*

6, ANOVA is done for Method (A) through Analysis Tool Pack of Excel. Summary of the same is shown in *Table 9*. From this table, only the results of Method are taken for final summary of ART ANOVA. Remaining all information is ignored.

ANOVA for Area (B). Based on aligned ranks given in *Table 7*, ANOVA is done for Area (B) through Analysis Tool Pack of Excel. Summary of the same is shown in *Table 10*. From this table, only the results of Area are taken for final summary of ART ANOVA and remaining all information is ignored.

ANOVA for Interaction of IVs Method (A) × Area (B). Based on aligned ranks given in *Table 8*, ANOVA is done for interaction between IVs [Method (A) × Area (B)] through Analysis Tool Pack of Excel. Summary of the same is shown in *Table 11*. From this table, only the results of Method (A) × Area (B) are taken for final summary of ART ANOVA and remaining all information is ignored.

Table 9

Summary of ANOVA for Method (A)

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Method (A)	2406.667	1	2406.667	8.608019	0.00490427	4.019541
Area (B)	311.925	2	155.9625	0.557837	0.57570913	3.168246
Method (A) × Area (B)	146.3583	2	73.17917	0.261743	0.77067984	3.168246
Within	15097.55	54	279.5843			
Total	17962.5	59				

Table 10

Summary of ANOVA for Area (B)

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Method (A)	9.6	1	9.6	0.036765	0.84866313	4.019541
Area (B)	3628.8	2	1814.4	6.948618	0.0020636	3.168246
Method (A) × Area (B)	242.8	2	121.4	0.464926	0.63067239	3.168246
Within	14100.3	54	261.1167			
Total	17962.5	59				

Table 11

Summary of ANOVA for Interaction Between Method (A) and Area (B)

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Method (A)	9.6	1	9.6	0.087619	0.76836111	4.019541
Area (B)	27.1	2	13.55	0.123671	0.88392	3.168246
Method (A) × Area (B)	12028.3	2	6014.15	54.89125	9.7591E-14	3.168246
Within	5916.5	54	109.5648			
Total	17962.5	59				

Table 12

Summary of ART ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df₁</i>	<i>df₂</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Method (A)	2406.667	1	54	2406.667	8.60801918	0.004904	4.019541
Area (B)	3628.8	2	54	1814.4	6.94861811	0.002064	3.168246
Method (A) × Area (B)	12028.3	2	54	6014.15	54.8912533	9.76E-14	3.168246

Step 5: Final ART ANOVA

Summary of final ART ANOVA is prepared as shown in *Table 12* by taking required results for Method, Area and Interaction between IVs from *Table 9, 10 and 11* respectively. In *Table 12* $df_2 = 54$ is taken for each row. It is a *df* of Within Group as shown in *Table 9, 10 and 11*.

Step 6: Interpretation of the Results of ART ANOVA

Based on the details given in *Table 12*, hypotheses are tested. It can be done in two ways as follows.

- Calculated *F* value is compared with *F Crit.* (Critical) value to check the significance of the difference between means of the concerned group. If $F < F \text{ Crit.}$ is there then the hypothesis is rejected or else hypotheses is not rejected.
- In another way, *P- Value* is compared with .05 and/or .01. If $P\text{- Value} < .01$ is there, then hypothesis rejected at .01 level of significance. If $.01 < P\text{- Value} < .05$ is there, then hypothesis is rejected at .05 level of significance.
- In all other cases *P- Value* fails to reject null hypothesis.
- After testing the hypotheses, Post Hoc test is done, if required.

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STEM Education for a Future-Ready Society

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India's Tomorrow Begins in Today's Classrooms

India is on the path of transformation. As we strive for a prosperous and sustainable future, the cornerstone must be laid through education – especially in science, technology, engineering, and mathematics (STEM). In a country as diverse and rapidly changing as ours, building a future-ready society calls for nurturing young minds that can think critically, innovate boldly, and act responsibly.

However, the path from classroom learning to real-life application remains challenging, particularly in rural and underserved areas. In Gujarat while educational access has improved, the disconnect between textbook-based learning and real-world problem-solving continues to hold back many students.

Preparing for Tomorrow

For development to be inclusive and sustainable, a strong foundation in science and technology is essential. Creating a future-ready society involves more than building infrastructure or designing policies, it requires investing in people. Scientists, engineers, technologists, and innovators will be key to addressing the complexities of today and seizing the opportunities of tomorrow.

The world is facing shared challenges: climate change, food insecurity, poverty, water and sanitation issues, pollution, and the need for clean energy. These require innovative, interdisciplinary solutions based on science and sustainability. Future generations need to be equipped with the right skills and mindset to tackle these complex problems.

If we continue to rely solely on conventional systems of education, students may lack the competencies required for the job market or to thrive in a fast-evolving world. STEM education is one of the most effective ways to respond to changing workforce demands and prepare children for the uncertainties of the future.

India has also set ambitious national goals – achieving net zero emissions by 2070 and becoming a *Viksit Bharat* by 2047. Achieving these goals will require a generation of

problem-solvers and leaders who are grounded in science, sustainability, and innovation.

Barriers to Science Learning

Many students in India remain hesitant to pursue careers in science or technology. This is often due to limited exposure, lack of hands-on opportunities, and a rigid, exam-oriented education system. In many schools, especially in rural and semi-urban areas, science continues to be taught mainly through textbooks, with minimal opportunities for experimentation or discovery.

When confronted with real-life situations, students are rarely required to apply isolated knowledge of physics or mathematics. What is needed is an integrated ability to draw on multiple concepts and solve problems. This is where STEM education becomes important.

Moreover, the growing culture of early competitive exam preparation, increasing dependence on coaching centres, and the trend of dummy schooling disconnect students further from experiential and joyful learning.

Bringing Policy to Practice

While national policies provide a strong framework, real change happens in classrooms and communities. The challenge lies in translating these ideas into action on the ground. Gujarat offers both opportunities and lessons in this journey.

Gujarat Context

The situation in Gujarat reflects this broader national picture. While the State has made progress in enrolment and literacy rates, challenges remain in making science and mathematics engaging for all students. Many government schools still lack properly equipped laboratories, and teachers often do not receive adequate support for activity-based teaching.

Without practical exposure, students struggle to develop problem-solving skills, creativity, and confidence. These gaps in experiential learning are a key barrier to creating a future-ready society.

Meanwhile, we are living in times of rapid change, from climate variability and health emergencies to digital disruptions. Addressing such challenges needs a different kind of education, that empowers students with skills to think, innovate, and act.

What is STEM Education?

STEM stands for Science, Technology, Engineering, and Mathematics. But more than a group of subjects, STEM is an integrated and applied approach to learning. It

encourages students to explore, question, experiment, design, and build. It promotes curiosity, critical thinking, and problem-solving—connecting classroom knowledge to real-world contexts.

STEM is about learning by doing. For instance, building a simple water purifier may combine scientific principles, engineering design, digital tools, and mathematical reasoning. Students learn not just the theory but how to apply it meaningfully.

Through this approach, students develop 21st century skills—critical thinking, collaboration, digital literacy, creativity, and communication. These are not just job skills, but life skills for responsible citizenship.

STEM education should be experiential, hands-on, and learner-centred. It should create an environment where children can build confidence, solve local problems, and see themselves as agents of change.

“We must strive towards a society where every individual is empowered to question, explore, and contribute.” — Dr. Vikram Sarabhai.

This vision continues to guide our efforts in making science and education meaningful and accessible for all.

VASCSC’s Role in Promoting STEM

Institutions like the Vikram A Sarabhai Community Science Centre (VASCSC) have pioneered hands-on learning for decades. VASCSC promotes innovative tools for STEM education, including STEM Labs in schools, mobile science lab, thematic exhibitions, teacher training workshops, STEM teaching-learning materials (TLMs), and outreach to rural and tribal schools.

Through these efforts, VASCSC has demonstrated how STEM can be made inclusive, relevant, and exciting. These models serve as important case studies for how experiential learning can be integrated into the wider education system.

VASCSC’s commitment to hands-on STEM learning has been nationally recognized, including the Times of India Social Impact Award and the National Award for Science & Technology Communication by DST, Govt of India.

Alignment with National and State Priorities

India's policy landscape is increasingly favourable towards STEM. The National Education Policy (NEP) 2020, the draft Science, Technology, and Innovation Policy (STIP), NIPUN Bharat, and the new National Curriculum Framework (NCF), all stress the importance of conceptual, experiential, and interdisciplinary learning.

- NEP 2020 promotes flexibility in subject choices, foundational numeracy and literacy, coding and digital skills, and creativity. It encourages moving away from rote learning to a more integrated, practical approach.
- STIP emphasizes inclusive science education, grassroots innovation, open science, public engagement, and indigenous technologies.
- NIPUN Bharat and the new NCF highlight foundational learning and connect STEM competencies to early grades, with a focus on making science enjoyable and accessible.
- PM SHRI Schools, including many in Gujarat, are also focusing on integrating STEM labs, digital classrooms, and sustainability components into mainstream schooling.

Building a Robust STEM Ecosystem in Gujarat

Gujarat has a unique opportunity to develop a strong, interconnected STEM ecosystem. This includes formal schools, science outreach centres, civil society groups, and government institutions working together.

Important components of this ecosystem include Gujarat Science City, District Community Science Centres supported by GUJCOST, Regional Science Centres at Rajkot, Patan, Bhavnagar, Bhuj, and Vadodara set up by GUJCOST, i-Hub and Atal Tinkering Labs for student innovation, GCERT and Gujarat Science Academy.

VASCSC plays a key role with its STEM Labs, Mobile STEM Laboratories, and teacher development programs. These efforts bring science learning to where it is needed most -in rural, remote, and tribal areas.

Technology, including virtual labs, robotics kits, AR/VR, and AI tools, can be powerful in scaling STEM education. But introducing these tools must go together with teacher capacity-building and alignment with local needs and realities.

Crucially, the STEM ecosystem must be inclusive. It must address gender imbalances, economic disparities, and the needs of children with disabilities, ensuring no one is left behind.

STEM for Sustainability and Innovation

STEM is not just about preparing for jobs. It is about preparing for life. It offers ways to address local problems through scientific thinking and sustainable innovation.

In Gujarat, this could mean - Learning how solar energy can power homes and devices, using weather data for smart farming, creating low-cost irrigation or water-saving solutions in drought-prone areas, applying science for climate resilience and better public health.

By embedding sustainability and ethics in STEM education, we can help students connect their learning to societal well-being.

Why STEM Matters for a Sustainable Future

STEM contributes directly to achieving the Sustainable Development Goals (SDGs) – whether it is clean water (SDG 6), quality education (SDG 4), affordable clean energy (SDG 7), or climate action (SDG 13). Through localized STEM projects, students can learn not just to understand the world but to improve it.

The Way Forward

To realise the full potential of STEM education in Gujarat and across India, we should:

- Integrate hands-on STEM activities into school curriculum
- Invest in teacher training for inquiry-based and interdisciplinary education
- Establish STEM Labs in every high school
- Strengthen partnerships between schools, science centres, NGOs, and government
- Use mobile STEM labs to reach last-mile schools
- Ensure inclusivity and accessibility in all STEM initiatives
- Embed sustainability and relevance in teaching content

A Shared Responsibility for Tomorrow

India is at a pivotal moment. Gujarat has the potential to lead by example and become a model for integrating STEM education in a meaningful, inclusive, and future-facing way.

The responsibility for building a future-ready society does not rest with educators alone. Policymakers, civil society, parents, and communities all have a role to play. Let us come together across sectors to reimagine education, empower our children, and shape a more just, sustainable, and innovative India.

By investing in STEM education today, we are not just building a stronger workforce - we are nurturing a generation that will take ownership of our challenges and create

innovative, sustainable solutions. Let us work together to ensure that every child, regardless of background, has access to the tools and opportunities they need to build a better tomorrow.

Making Inclusive Education penetrate in school classrooms through TEI

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Abstract:

Inclusive Education is a philosophy, a vision, and a process. It is multi-faceted and complex. In today's India, where we have laws, policies, and curriculum frameworks that suggest "inclusion of children with disabilities in a mainstream classroom"; there are some basic questions that come to mind related to the systemic and structural aspects of our education system: 1) What is Inclusive Education and how does it fit into our current education system? 2) Are our school systems ready for inclusion? , and 3) Are our teachers trained to understand, accept, and work with children who have diverse needs? Teachers are the founding pillars of any education system. Inclusive Education doesn't happen in isolation, it is realised only when various components of the education system work together. In India, where general and special education teachers receive separate training, it becomes all the more important that we focus on teacher education as a means to promote inclusion.

Key words: Inclusive education, Teacher Education, Student-Centered Learning, Rights of Children with Disabilities, Diverse needs

Inclusive Education

What is the status quo?

Every child, including children with disabilities, have a right to education. By law, a person or student with disability is defined as a person with long term physical,

mental, intellectual or sensory impairment which, in interaction with barriers, hinders his full and effective participation in society equally with others.

The United Nations Convention on the Rights of Persons with Disabilities (CRPD) emphasizes that inclusive education is a fundamental human right for every child with disability. The Rights to Persons with Disability Act, 2016 has been passed in India, to give effect to matters connected with or incidental to the United Nations Convention on the Rights of Persons with Disabilities. This Act defines **Inclusive education** as a “system of education wherein students with and without disability learn together and the system of teaching and learning is suitably adapted to meet the learning needs of different types of students with disabilities.”

Learning and teaching are complex processes. Their complexity increases when these processes are to be modified and accommodated to cater to the special educational needs of children with diverse needs. These children get stuck in a vicious cycle, wherein assumptions about their learning potential and attached diagnostic labels; lead to less opportunities for their learning, and less opportunities for learning in turn leads them to be excluded from developmentally-appropriate and inclusive learning opportunities and environments.

Though the law and the United Nations considers inclusive education a fundamental right for every child with disability, for many it is still a luxury. I have been working with neurodivergent children between the ages of 3-12 years. Neurodiversity is the term that is currently used across the sectors involving individuals with the Autism Spectrum Disorder, Specific Learning and Intellectual Disorders, and Attention Deficit Hyperactivity Disorders. My experiences of working with these children and their families has taught me a lot about what it means to be different and the price you pay for that.

The on ground reality still makes Inclusive Education a far fetched dream for many children with disabilities. All things that typically developing people take for granted are nothing short of a struggle for these children and their families. Every phase of life is an uphill battle for them, from trying to get an appropriate diagnosis, to finding a preschool that will include a neurodivergent child, to looking for a shadow teacher to

accompany the child in the mainstream classroom, keeping up with therapies, and the list continues. And this is just the first 5 years of their lives. Come year 6, these children and their parents are left with little to no options for their education and schooling after preschool. But again, attending a preschool or anganwadi is also a "privilege" that very few of them get. Other than very few "inclusive mainstream schools" that take them, with or without a shadow teacher, the options these children are left with are exclusive set ups like special schools or different therapy centers. They are therefore clearly segregated from society from the very early stages of their lives.

Teacher Education in India: A Catalyst for making Indian School Classrooms Inclusive

Why should we focus on teacher education in India and make it a tool to let inclusion penetrate our school classroom?

Across the literature on Inclusive Education, one of the recurring themes is "teacher training". Article 24 of the UNCRPD mentions what is needed to ensure that children with disabilities receive Inclusive Education. "Trained Teachers" is one of the mentioned needs among others like non-discrimination, non-exclusion, access to primary and secondary education, reasonable accommodation, general support, individual education plans, and specific services for specific impairments.

The teacher in a classroom can be **a first responder**-who observes and brings to light the needs and challenges of these children; **an advocate**- who makes sure their potential and strengths are highlighted, **a crusader of change** who makes sure that their differences are celebrated and not discriminated against. They can be the glue that holds all other parts together when it comes to the child's education and inclusion in the community. An important stakeholder who bridges the gap between the families and the community. They can be gatekeepers to community engagement and inclusion when it comes to children with disabilities. If a class teacher in a mainstream classroom accepts and accommodates the needs of a child with disability, it increases the chances of the child being included in many other areas of their social lives.

The impact and implications of the crucial role of a general educator in realising all other requirements of "Inclusive Education" is clear and obvious. But the challenge is always translating an ideal idea into an effective practice. Reflecting on the current

challenges with Inclusive Education and Teacher Education we realise that teachers are not being trained to be the leaders or gatekeepers of the movement; rather they are passive consumers of the “Inclusion” debate. Their training should foster their active participation and leadership when it comes to inclusive education.

A Case for Student-Centered Approach to promote Inclusive Education through Teacher Education in India

When analysing current B.Ed syllabi; it can be noticed that “Inclusive Education” is just one topic under a section like “Perspectives on Education”. It is still being taught only as a perspective, which does not necessarily help build competencies and attitudes that are required to practise inclusion in classrooms.

“Inclusive Education” should not be treated as an isolated subject or theory when it comes to designing a curriculum for teacher education. It should be a principle upon which teaching fundamentals and approaches are built throughout the coursework. To prepare teachers for inclusive education, the curriculum should move away from “content centered approach”. When a curriculum is majorly content centered, the starting point of learning is the subject matter in a linear sequence of topics (Naidu, 2004). The students studying these topics are being exposed to what others have to say about the topics, instead of engaging in building their own perspectives and competencies on the given subject matter.

The Curriculum should promote learning that is:

- 1. Student Centered**
- 2. Contextually Embedded:**
 - a. Inner Context i.e. Beliefs & Attitudes**
 - b. Outer Context i.e. actual place of practice**

The curriculum should allow them to gain knowledge on theories and best practices, while giving them learning opportunities to practice these concepts in the actual context, and then reflect on their experiences. This will enable them to map out their own strategies and equip themselves with a mindset and skillset that will empower

them as mainstream teachers of Inclusive Classrooms. When the curriculum supports student centered learning it naturally leads to it being contextually embedded. Along with cultivating knowledge and competencies; the attitudes and beliefs of the trainee teachers also have to be addressed. How they view disability, the disabled, and inclusion will affect their approach to Inclusive Education and have implications on their future classroom practices.

Curriculum and Pedagogic Studies is the core area where the focus needs to shift. Inclusive practices need to penetrate into the subjects where teachers are actually trained to design, develop, implement and evaluate curriculum and pedagogical practices. These areas need to include a design thinking approach to planning for teaching and learning. They need to include concepts like “Differentiated Instruction” and “Universal Design for Learning”. This means “Creating an Inclusive Classroom” should be a topic spread across semesters & study areas to cover the nuances of the concept in depth.

This can be done by incorporating “**Exposure, Experience, and Reflection**” as part of teaching Inclusive Education to student-teachers. *Inquiry- Based Approach* is one such type of student-centered and contextual learning approach that can serve the purpose of targeting attitudes & beliefs, knowledge gaps, and capacity building. The goal of any student-centered learning environment is to build on existing knowledge since prior knowledge strongly affects future learning (Froyd and Simpson, 2008). If teacher education supports such learning then it can cause improved learning motivation, knowledge retention, comprehension, and constructive attitudes about the subject material (Islam et al., 2022).

A Roadmap for the future:

A roadmap which can serve as the starting point to navigate the change in approach to Inclusive education within the general teacher education curriculum is mentioned below.

A FRAMEWORK FOR TEACHER EDUCATION TO PROMOTE INCLUSIVE EDUCATION

<i>Pillars of SCL*</i>	EMOTIONS	KNOWLEDGE	SKILLS
	Seeing & Feeling	Knowing	Doing
<i>Core Areas of Syllabus</i>	Inclusion as a perspective in Education.	Curriculum & Pedagogic Studies	Internships & Research Projects
<i>Targeted Themes</i>	-Attitudes & Beliefs -Misconceptions & Myths	-Curriculum and pedagogic accommodations. - Evidence-Based Practices	-Experiential learning. -Collaborative and co-operative Teaching.
<i>Expected Outcomes</i>	Reduce and eliminate Labelling, Discrimination, and Segregation	-They learn to build their own knowledge on various aspects of Inclusive education -Information Literacy	-Hands-on experience and skill building in teaching techniques and areas beyond teaching skills. -Learning in Realistic-settings.
<i>Guiding Questions</i>	- What is inclusion? What are the goals of the inclusion program? -Is inclusion for all students with disabilities or just for certain ones? -Do students with disabilities have the skills to be successful?	-Am I expected to teach the general education curriculum to everyone? How can I do that? -What instructional accommodations, technologies, and classroom management strategies do I need to use?	-What does it mean to work collaboratively with other professionals? Will I be able to work collaboratively with others? -Will I receive enough time to collaborate and communicate with others? -What type of training and administrative support will I receive to help me implement inclusion successfully?

***SCL-Student-centered Learning**

An Endnote for an Inclusive Future:

In summary, we need to remember that for children to flourish and thrive, all of their fundamental rights need to be realized. All human rights are interlinked; therefore

realization of one right opens doorways to realization of other human rights. Future teachers have to understand that Inclusion is a process; and the outcome of it is the realization of fundamental Human Rights. Inclusive Education should be projected as a concept that is synonymous to Quality Education and not an addition to it. It should be promoted as a non-negotiable parameter for providing quality education to a child. Teachers trained for inclusion can become active participants and leaders to realise this vision for Inclusive Education for all.

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Integrating Artificial Intelligence Technologies into Teacher Training

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Abstract

Artificial Intelligence (AI) is rapidly transforming educational landscapes worldwide, offering unprecedented opportunities to enhance teaching and learning processes. However, the successful integration of AI technologies in education heavily depends on teachers' readiness and AI literacy. This paper examines the current state of AI integration in teacher training programs through a comprehensive literature review. The research reveals a significant imbalance between technological development and teacher preparedness, with only 35% of studies focusing on teacher professional development compared to 65% examining AI applications in teaching. Using systematic review methodologies, this study identifies key challenges teachers face when adopting AI technologies, including knowledge gaps, limited access to resources, resistance to change, and ethical concerns. The findings highlight essential best practices for effective AI integration in teacher training : establishing clear objectives, maintaining skill balance between AI utilization and core teaching competencies, addressing ethics and integrity, implementing continuous monitoring and feedback mechanisms, and promoting ongoing professional development. The paper also explores various methodological approaches employed in AI education research, including case studies, mixed-methods research, and action research. This research contributes to the growing body of knowledge on AI in education by emphasizing the critical need for comprehensive teacher training programs that address both technological and pedagogical aspects of AI integration. The implications extend to educational institutions, policymakers, and teacher educators, underscoring the importance of preparing teachers for an AI-driven educational future while maintaining the human element that remains central to effective teaching.

Keywords: *Artificial Intelligence, teacher training, educational technology, NEP 2020, adaptive learning*

Introduction

The educational landscape is undergoing a profound transformation driven by rapid technological advancements, particularly in the field of Artificial Intelligence (AI). From conversational AI and chatbots to intelligent tutoring systems and automated assessment tools, AI technologies are reshaping how we conceptualize teaching and learning (Romero Rodríguez et al., 2023). These innovations promise to enhance educational experiences through personalized learning, adaptive systems, and intelligent tutoring (Wangetal.,2021). However, the successful integration of AI in education hinges critically on one factor: teacher preparedness. Despite the accelerating development and deployment of AI technologies in educational settings, there exists a substantial gap between technological innovation and teacher readiness. Recent systematic reviews indicate that while 65% of research focuses on AI applications in teaching, only 35% addresses teacher professional development needs (Tan et al., 2024). This imbalance highlights a critical challenge: as AI technologies advance, teachers often lack the necessary training, skills, and support to effectively integrate these tools into their pedagogical practices.

The significance of addressing this gap cannot be overstated. Teachers serve as the primary mediators between educational technologies and students, making their technological competence and pedagogical understanding of AI essential for meaningful implementation. Without adequate training, even the most sophisticated AI tools may fail to achieve their intended educational outcomes or, worse, may be misused or underutilized in classroom settings (DeLaHiguera,2019).

This research paper aims to examine the current approaches to integrating AI in teacher training, identify the challenges teachers face when adopting AI technologies, and explore best practices that can enhance teacher preparation for AI integration. By addressing these questions, this study contributes to the growing discourse on how educational institutions can better prepare teachers for an increasingly AI-driven educational environment.

The current landscape of AI adoption in education reveals both promising developments and concerning trends. While higher educational institutions are increasingly focusing on AI adoption (Bates et al., 2020; Knox, 2020), many teachers remain unprepared for this technological shift. They face numerous challenges, including limited technical knowledge, restricted access to necessary resources,

concerns about privacy and ethics, and difficulties integrating AI into existing curricula (Aljemely, 2024). These challenges underscore the need for comprehensive training programs specifically designed to address the unique requirements of AI integration in education.

This paper is structured to provide a thorough examination of the topic. Following this introduction, a literature review explores the historical context of technology integration in teacher education, the theoretical frameworks for technology adoption, and the current state of AI in education. The methodology section outlines research approaches commonly employed in this field, while the findings and discussion section present key challenges, best practices, and case studies of successful AI integration in teacher training. The paper concludes with ***implications for educational stakeholders and recommendations for future research and practice in this rapidly evolving field.***

Literature Review

The integration of technology in teacher education has evolved significantly over the past few decades, transitioning from basic computer literacy to sophisticated AI applications. This literature review examines the historical context, theoretical frameworks, current state of AI in education, teacher readiness, challenges in AI integration, and existing training models to provide a comprehensive understanding of the landscape.

Historical Context of Technology Integration in Teacher Education

The journey of technology integration in teacher education began in the 1980s with the introduction of computers in schools, focusing primarily on basic computer literacy (Culpetal.,2005).The1990s witnessed the emergence of educational software and the internet, shifting the focus toward integrating technology into pedagogical practices. By the early 2000s, digital literacy became a core component of teacher education programs, with standards such as the International Society for Technology in Education (ISTE) Standards guiding technology integration in teacher preparation (Mishra & Koehler,2006).The past decade has seen rapid advancements in AI technologies, creating new imperatives for teacher education to prepare educators for an AI-enhanced educational environment (Holmes et al., 2022).

Theoretical Frameworks for Technology Adoption in Education

Several theoretical frameworks guide technology adoption in education, providing valuable lenses through which to understand AI integration in

teacher training. The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006), emphasizes the complex interplay between technology, pedagogy, and content knowledge required for effective technology integration. The SAMR (Substitution, Augmentation, Modification, Redefinition) model proposed by Puentedura (2006) offers a progression for technology adoption, from merely replacing traditional tools to transforming educational experiences in ways previously impossible.

More recently, frameworks specifically addressing AI in education have emerged. The AI Literacy Framework (Long & Magerko, 2020) outlines the knowledge, and skills educators need to understand and utilize AI effectively. Similarly, the AI Readiness Framework for Educators (Crompton & Burke, 2023) provides a structured approach to assessing and developing teachers' capacity to integrate AI into their practice. These frameworks collectively highlight the multifaceted nature of AI integration, requiring not only technical knowledge but also pedagogical understanding and ethical awareness.

Current State of AI in Education

AI technologies in education encompass a diverse range of applications, each with distinct implications for teaching and learning. Conversational AI and chatbots, exemplified by tools like ChatGPT, are increasingly being used for personalized learning experiences, language practice, and administrative support (Nguyen et al., 2023). AI-driven learning and assessment systems provide adaptive learning paths and automated feedback, allowing for more individualized instruction (Tang et al., 2023). Immersive technologies, including virtual and augmented reality enhanced by AI, create engaging learning environments that were previously unimaginable (Zhang & Aslan, 2021).

Visual and auditory computing applications, such as facial recognition for attendance and engagement monitoring, are gaining traction despite raising ethical concerns (Akgun & Greenhow, 2021). Teaching and learning analytics leverage AI to provide insights into student performance and teaching effectiveness, enabling data-driven decision-making (Chen et al., 2020). A systematic review by Tan et al. (2024) revealed that 65% of research on AI in education focuses on these applications, demonstrating the field's emphasis on technological development rather than teacher preparation.

Teacher Readiness and AI Literacy

Despite the proliferation of AI technologies in education, teacher readiness remains a significant concern. Research indicates substantial knowledge gaps among educators regarding AI concepts, capabilities, and limitations (De La Higuera, 2019). A study by Nazaretskyetal. (2022) found that many teachers lack confidence in their ability to integrate AI into their teaching practices, with limited understanding of how AI can enhance pedagogical approaches.

Digital competence requirements for effective AI integration extend beyond basic technological skills. Teachers need to develop AI literacy, which encompasses understanding AI fundamentals, recognizing AI capabilities and limitations, evaluating AI applications critically, and addressing ethical implications (Long & Magerko, 2020). This multifaceted literacy is essential for teachers to make informed decisions about AI integration and to guide students in developing their own AI literacy (Gillani et al., 2023).

Challenges in AI Integration

Teachers face numerous challenges when adopting AI technologies. Technical barriers include limited access to necessary hardware, software, and reliable internet connectivity, particularly in under-resourced schools(Aljemely,2024). Pedagogical concerns center on the difficulty of aligning AI tools with existing curricula and teaching approaches, as well as uncertainty about how to effectively leverage AI to enhance learning outcomes rather than simply automating traditional practices(Fitria,2021).

Ethical considerations present another significant challenge. Issues of privacy, data security, algorithmic bias, and the potential for AI to exacerbate existing educational inequities raise important questions about responsible AI use (Holmes et al., 2022). Additionally, many teachers express concerns about AI potentially replacing human elements of teaching or diminishing their role in the educational process (Tao et al., 2019). These challenges highlight the need for comprehensive training that addresses not only technical aspects but also pedagogical and ethical dimensions of AI integration.

Existing Training Models and Approaches

Current approaches to preparing teachers for AI integration vary widely in scope and effectiveness. Pre-service teacher education programs increasingly incorporate

technology courses, though many still lack specific focus on AI (Polak et al., 2022). In-service professional development initiatives range from one-time workshops to sustained programs, with the latter generally proving more effective for meaningful technology integration (Vlasova et al., 2019).

Self-directed learning opportunities, including online courses, communities of practice, and resource repositories, offer flexible options for teachers to develop AI competencies at their own pace (Paiva & Bittencourt, 2020). However, research by Aljemely (2024) suggests that the most effective training models combine technical skill development with pedagogical application, provide hands-on experience with AI tools, address ethical considerations, and offer ongoing support as teachers implement AI in their classrooms.

Despite these various approaches, a significant gap remains between the rapid advancement of AI technologies and the preparation of teachers to effectively integrate these tools. This gap represents a critical area for further research and development, particularly as AI continues to transform educational possibilities and expectations. As Romero Rodríguez et al. (2023) argue, the future of AI in education depends not only on technological innovation but also on our ability to prepare teachers who can thoughtfully and effectively leverage these technologies to enhance teaching and learning.

Methodologies

This section examines the methodological approaches commonly employed in research on AI integration in teacher training. Understanding these methodologies provides insight into how knowledge in this field is constructed and offers a foundation for evaluating the quality and reliability of findings in this emerging area of educational research.

Overview of Research Approaches

Research on AI integration in teacher training employs diverse methodological approaches, each offering unique perspectives on this complex phenomenon. Systematic reviews have emerged as a particularly valuable approach for synthesizing the growing body of literature. Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology, researchers like Tan et al.

(2024) and Aljemely (2024) have conducted comprehensive analyses of existing studies, identifying patterns, gaps, and trends in the literature. These reviews typically involve rigorous search strategies, predefined inclusion and exclusion criteria, and structured data extraction processes to ensure methodological rigor. Case studies represent another prominent approach, offering in-depth examinations of specific AI integration initiatives in teacher education programs or schools. These studies provide rich contextual information about implementation processes, challenges, and outcomes in real-world settings. For example, Huang et al. (2021) documented the implementation of an AI-enhanced professional development program for teachers, capturing the nuanced experiences of participants and the contextual factors influencing success.

Mixed-methods research combines quantitative and qualitative approaches to provide a more comprehensive understanding of AI integration in teacher training. Romero Rodríguez et al. (2023) employed surveys to assess teachers' AI literacy levels quantitatively while also conducting interviews to explore their experiences and perceptions qualitatively. This methodological triangulation strengthens the validity of findings by capturing both breadth and depth of understanding.

Action research, characterized by iterative cycles of planning, action, observation, and reflection, has proven particularly valuable for developing and refining AI training programs for teachers. This approach involves teachers as co-researchers, empowering them to actively participate in the research process and ensuring that findings directly inform practice. Paiva and Bittencourt (2020) utilized action research to develop an AI literacy framework for teachers, refining it through multiple iterations based on teacher feedback and observed outcomes.

Data Collection Methods

Researchers investigating AI integration in teacher training employ various data collection methods to capture different aspects of this multifaceted phenomenon. Surveys and questionnaires are commonly used to gather information about teachers' knowledge, attitudes, and practices related to AI. These instruments often include Likert-scale items to measure constructs such as AI literacy, perceived usefulness, and intention to adopt AI technologies. Nazaretsky et al. (2022) developed and validated a survey instrument specifically designed to assess teachers' AI

readiness, demonstrating the importance of reliable measurement tools in this field.

Interviews with educators provide deeper insights into their experiences, challenges, and perceptions regarding AI integration. Semi-structured interviews allow researchers to explore predetermined topics while remaining flexible enough to pursue emerging themes. Focus groups offer the additional benefit of capturing interactions among participants, revealing shared understandings and points of contention. Vlasova et al. (2019) conducted in-depth interviews with teacher educators to understand how they conceptualize AI literacy and incorporate it into their teaching.

Classroom observations enable researchers to document how teachers actually implement AI technologies in practice, often revealing discrepancies between stated intentions and actual behavior. Structured observation protocols help ensure consistency across different classrooms or time points. Zhang and Aslan (2021) developed an observation framework specifically for assessing AI integration in teaching practices, focusing on both technological implementation and pedagogical approaches.

Document analysis of curricula, lesson plans, policy documents, and training materials provides valuable information about the formal aspects of AI integration in teacher education. This method helps researchers understand how AI is conceptualized and positioned within official frameworks and institutional contexts. Polak et al. (2022) analyzed teacher education curricula across multiple institutions to assess the extent and nature of AI-related content.

Analytical Frameworks

The analysis of data collected through these various methods typically employs one or more analytical frameworks to organize and interpret findings. Thematic analysis is widely used for qualitative data, involving the identification, analysis, and reporting of patterns or themes within the data. This approach allows researchers to identify recurring challenges, successful strategies, and emerging concerns related to AI integration in teacher training. Holmes et al. (2022) employed thematic analysis to identify key ethical considerations in AI education based on interviews with teachers and teacher educators.

Content analysis, which can be applied to both qualitative and quantitative data, involves systematically categorizing and quantifying content according to predetermined or emergent categories. This approach is particularly useful for analyzing

documents, transcripts, and open-ended survey responses. Gillani et al. (2023) used content analysis to examine how AI literacy is conceptualized in teacher education materials across different countries.

Statistical approaches, ranging from descriptive statistics to inferential analyses and structural equation modeling, are employed to analyze quantitative data and test hypotheses about relationships between variables. Chen et al. (2020) used regression analysis to examine factors predicting teachers' intention to adopt AI technologies, identifying significant relationships between perceived usefulness, ease of use, and adoption intentions.

Presentation, Findings and Discussion

This section presents and discusses key findings regarding the integration of technology and AI in teacher training, drawing on the research literature and best practices identified in the field. The discussion examines the current state of teacher training for AI integration, key challenges, best practices, case studies, pedagogical frameworks, impact on teaching practices, and future directions.

Current State of Teacher Training for AI Integration

The research literature reveals a significant imbalance in the focus of AI in education studies. According to the systematic review by Tan et al. (2024), approximately 65% of studies examine the application of AI in teaching, including technologies such as conversational AI, AI-driven learning and assessment systems, immersive technologies, visual and auditory computing, and teaching and learning analytics. In contrast, only 35% of studies explore AI's role in enhancing teacher professional development. This disparity highlights a critical gap in research addressing the development needs of teachers as they integrate AI technologies into their teaching practices.

This imbalance reflects a broader trend in educational technology implementation, where technological innovation often outpaces teacher preparation. As Aljemely (2024) notes, "Educational institutions are training teachers to utilize AI in teaching. However, there is a dearth of investigation on the training of teachers to utilize AI." This gap between the supply of professional development opportunities and the demand for AI skills among teachers creates a

significant barrier to effective AI integration in educational settings.

The current landscape of teacher training for AI integration is characterized by fragmentation and inconsistency. Pre-service teacher education programs vary widely in their approach to AI, with many still focusing on basic technology integration rather than specifically addressing AI competencies (Polak et al., 2022). In-service professional development opportunities are often limited to short-term workshops that provide introductory exposure to AI tools but fail to support deeper understanding or sustained implementation (Vlasova et al., 2019).

Furthermore, there is a notable disconnect between the theoretical frameworks guiding AI in education research and the practical training provided to teachers. While researchers have developed sophisticated models for understanding AI integration, such as the AI Literacy Framework (Long & Magerko, 2020) and the AI Readiness Framework for Educators (Crompton & Burke, 2023), these frameworks have not been widely translated into comprehensive training programs accessible to the average teacher.

Key Challenges Identified

Teachers face numerous challenges when adopting AI technologies, which must be addressed through effective training programs. First, knowledge and skill gaps represent a fundamental barrier to AI integration. Many teachers lack basic understanding of AI concepts, capabilities, and limitations, making it difficult for them to evaluate AI tools critically or implement them effectively (De La Higuera, 2019). Technical skills required for AI implementation, such as data literacy and basic programming concepts, are often underdeveloped among educators (Nazaretsky et al., 2022).

Second, limited access to resources and infrastructure creates practical obstacles to AI integration. Many schools face constraints related to hardware, software, reliable internet connectivity, and technical support (Mohd Nizar et al., 2018). These resource limitations are particularly pronounced in under-resourced schools and regions, raising concerns about equity in AI implementation. Training programs that fail to account for these resource constraints may inadvertently exacerbate existing educational inequities.

Third, resistance to change and technology adoption remains a significant challenge. Some teachers express skepticism about AI's value in education or fear that AI

technologies might eventually replace human teachers (Tao et al.,2019). Others experience anxiety about the inability to master new technologies or concern about how AI adoption might change their professional identity and role. Effective training must address these psychological barriers along side technical skill development.

Fourth, ethical concerns and privacy issues create complex challenges for AI implementation. Teachers need guidance on navigating issues related to student data privacy, algorithmic bias, transparency, and the potential for AI to reinforce existing inequities (Holmes et al.,2022). Without adequate training in AI ethics, teachers may inadvertently implement AI in ways that compromise student privacy or perpetuate biases.

Finally, the lack of customized training programs tailored to different educational contexts and teacher needs represents a significant challenge. Generic approaches to AI training often fail to address the specific requirements of different subject areas, grade levels, student populations, and resource contexts (Aljemely,2024).This one-size-fits-all approach limits the relevance and applicability of training for many teachers.

Best Practices for Effective AI Integration in Teacher Training

Research has identified several best practices that can enhance the effectiveness of AI integration in teacher training. First, establishing clear objectives and purpose-driven integration is essential. Training programs should help teachers identify specific educational goals that AI can help address, rather than promoting technology adoption for its own sake (Teaching Channel, 2024). This approach ensures that AI integration is aligned with meaningful educational outcomes and helps teachers maintain focus on pedagogical purposes rather than technological novelty.

Second, maintaining skill balance between AI utilization and core teaching competencies is crucial. Effective training emphasizes that AI tools should supplement, not replace, essential teaching skills and human elements of education (Fitria, 2021).

This balanced approach helps teachers leverage AI to enhance their teaching while preserving the interpersonal and creative aspects of education that remain distinctly human.

Third, addressing ethics and integrity in AI application must be a central component of teacher training. Programs should help teachers understand ethical considerations

related to AI use, including privacy, consent, equity, and transparency (Schiff, 2022). This ethical foundation enables teachers to make responsible decisions about AI implementation and to guide students in developing their own ethical understanding of AI.

Fourth, implementing continuous monitoring and feedback mechanisms supports ongoing improvement in AI integration. Training should equip teachers with strategies for evaluating the effectiveness of AI tools in their specific context and for making data-informed adjustments to their implementation approach (Teaching Channel, 2024). This iterative process helps teachers refine their AI integration practices over time based on evidence of impact.

Finally, promoting ongoing professional development recognizes that AI integration is not a one-time achievement but a continuous journey. Effective training programs provide sustained support through communities of practice, mentoring relationships, and regular opportunities for skill enhancement (Paiva & Bittencourt, 2020). This ongoing support helps teachers adapt to rapidly evolving AI technologies and deepen their integration practices over time.

Case Studies of Successful AI Integration in Teacher Training

Several case studies illustrate successful approaches to AI integration in teacher training across different educational contexts. In pre-service teacher education, the University of Helsinki's Elements of AI course represents an innovative approach to developing AI literacy among future teachers. This open-access course introduces fundamental concepts of AI in an accessible format, helping teacher candidates develop both technical understanding and critical perspectives on AI in education (Crompton & Burke, 2023). The program's success lies in its combination of technical content with pedagogical applications, helping future teachers bridge the gap between AI knowledge and classroom implementation.

In-service professional development initiatives have also demonstrated promising approaches. The AI4K12 Initiative in the United States has developed a framework of five big ideas in AI that guide teacher professional development across grade levels and subject areas. This initiative combines online resources with in-person workshops and professional learning communities, creating a comprehensive ecosystem for teacher learning about AI (Gillani et al., 2023). The program's emphasis on grade-level appropriate concepts and cross-curricular applications has made it particularly effective for supporting diverse teaching contexts.

School-wide implementation approaches provide another valuable model. Singapore's AI Apprenticeship Programme includes a specialized track for educators that combines technical training with collaborative curriculum development. This program takes a systemic approach, addressing both individual teacher capacity and institutional supports for AI integration (Chenetal.,2020). The initiative's success demonstrates the importance of aligning teacher training with broader institutional strategies for technology adoption.

These case studies share several common elements that contribute to their effectiveness: they combine technical knowledge with pedagogical application, provide hands-on experience with AI tools, address ethical considerations, offer ongoing support, and adapt to specific educational contexts. These elements align with the best practices identified in the literature and provide practical models for designing effective AI training programs.

Pedagogical Frameworks for AI Integration

Several pedagogical frameworks provide valuable guidance for AI integration in teacher training. The TPACK (Technological Pedagogical Content Knowledge) framework, developed by Mishra and Koehler (2006), emphasizes the intersection of technological, pedagogical, and content knowledge required for effective technology integration.

Applied to AI, this framework helps teachers understand how AI tools interact with subject matter content and pedagogical approaches, supporting more thoughtful integration decisions.

The SAMR (Substitution, Augmentation, Modification, Redefinition) model offers a progression for technology adoption, from simply replacing traditional tools to transforming educational experiences in ways previously impossible (Puentedura,2006). This model helps teachers move beyond superficial AI implementation toward more transformative applications that fundamentally enhance learning experiences.

AI-specific frameworks have also emerged to guide integration efforts. The AI Literacy Framework (Long & Magerko,2020) outlines the knowledge and skills educators need to understand and utilize AI effectively, including technical concepts, critical evaluation, and ethical considerations. Similarly, the AI Readiness Framework for Educators (Crompton & Burke, 2023) provides a structured approach to assessing and developing teachers' capacity to integrate AI into their practice.

These frameworks offer valuable conceptual tools for designing and implementing teacher training programs. By providing structured ways of thinking about AI integration, they help teachers move beyond adhoc or tool-focused approaches toward more systematic and pedagogically grounded implementation strategies.

Impact of AI Training on Teaching Practices

Effective AI training can significantly impact teaching practices across multiple dimensions. In instructional design, teachers who receive comprehensive AI training demonstrate greater ability to align AI tools with learning objectives, differentiate instruction using AI-enhanced approaches, and design learning experiences that leverage AI's capabilities while maintaining student engagement (Huangetal.,2021). These teachers are more likely to move beyond substitution-level implementation to more transformative applications that enhance e-learning in novel ways.

Assessment approaches also evolve as teachers develop AI literacy. Well-trained teachers can effectively implement AI-enhanced formative assessment, use AI tools to provide more timely and specific feedback, and design authentic assessments that evaluate students' ability to work with and critically evaluate AI (Akgun & Greenhow, 2021). These assessment innovations help teachers gather more nuanced information about student learning and provide more personalized support.

Classroom management practices shift as teachers integrate AI thoughtfully. Teachers with strong AI training demonstrate greater ability to establish appropriate norms for AI use, monitor student engagement with AI tools, and address ethical issues that arise in AI-enhanced learning environments (Romero Rodríguez et al., 2023). These management strategies help create productive learning environments that maximize AI's benefits while minimizing potential risks.

Student engagement often increases when teachers implement AI effectively. Research indicates that students working with teachers who have received comprehensive AI training show greater motivation, deeper learning, and more positive attitudes toward technology use (Tang et al., 2023). These engagement benefits appear to stem from teachers' ability to implement AI in ways that enhance student agency and provide meaningful learning experiences.

Future Directions for AI in Teacher Education

Looking ahead, several emerging technologies and approaches promise to shape the future of AI in teacher education. Adaptive AI training platforms that personalize professional development based on teachers' existing knowledge, learning preferences, and classroom context represent a promising frontier (Wamba-Taguimdje et al., 2020). These platforms apply the same adaptive learning principles to teacher education that AI brings to student learning, potentially increasing the efficiency and effectiveness of professional development.

AI-enhanced coaching and mentoring systems offer another promising direction, providing teachers with ongoing feedback and support as they implement AI in their classrooms (Paiva & Bittencourt, 2020). These systems can analyze teaching practices, suggest improvements, and connect teachers with relevant resources and communities of practice, extending the impact of formal training programs.

Immersive simulations powered by AI create environments for teachers to practice AI implementation strategies before applying them in real classrooms (Zhang & Aslan, 2021). These simulations can present diverse scenarios and student responses, helping teachers develop flexibility and confidence in their AI integration approaches.

Policy implications of these developments are significant. Educational systems need coherent policies that support teacher development in AI, including standards for AI literacy among educators, funding for comprehensive training programs, and incentives for schools to support ongoing professional learning (Miao et al., 2021). Without supportive policy frameworks, even the most innovative training approaches may struggle to achieve widespread impact.

Research opportunities abound in this rapidly evolving field. Longitudinal studies tracking the impact of different training approaches on teacher practices and student outcomes are needed to build a stronger evidence base for effective AI training (Schiff, 2022). Research on equity dimensions of AI training is particularly important, examining how to ensure that all teachers, regardless of school resources or geographic location, have access to high-quality professional development for AI integration.

As AI continues to transform educational possibilities, teacher education must evolve to prepare educators who can thoughtfully and effectively leverage these

technologies. The future of AI in education depends not on the technologies themselves but on our ability to develop teachers who can use these tools to enhance teaching and learning while maintaining the human connections that remain at the heart of education.

Conclusion

The integration of Artificial Intelligence in teacher training presents both major challenges and opportunities in modern education. This paper highlights a critical gap: while 65% of studies focus on AI in teaching, only 35% address teacher professional development, revealing a disconnect between innovation and teacher readiness. Teachers face diverse challenges—including skill gaps, limited resources, ethical concerns, and a lack of tailored training—that require holistic solutions. Best practices from research stress clear goals, balanced skill development, ethical awareness, continuous feedback, and sustained professional support. Pedagogical frameworks like TPACK and SAMR offer structured guidance for effective AI use in teaching. When well-trained, teachers can use AI to enhance instruction, assessment, classroom management, and student engagement, underscoring the transformative impact of thoughtful AI integration in education.

This research recommends enhancing AI integration in teacher training through comprehensive frameworks that address technical, pedagogical, and ethical aspects; differentiated training pathways tailored to teachers' diverse needs; and the creation of communities of practice for ongoing support. It also emphasizes embedding ethics in all training and fostering partnerships between educators, tech developers, and researchers to ensure tools and programs are relevant and effective.

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Strengthening Teacher Education through Internships

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Abstract

The very changing scope of education is brought about by the perspectives of the Gen Z and Gen Alpha students' as they present new sets of learning which in turn calls for a change in the way we prepare our teachers. In 2020's National Education Policy (NEP) and the National Curriculum Framework for Student Teachers (NCF-ST) we see that it is required of us to have in place teacher education programs that in addition to a strong subject base also develop the pedagogical skills to fit the many dimensions of today's modern teaching. We see that which will play a key role is the issue of internships which must be redefined to put more emphasis on the practical application of what is taught in the classroom. Through internships we see a chance to put into practice what is learned in theory and at the same time get familiar with the complex issues present in the real class room setting which in turn fosters adaptability, confidence and skill growth in the trainee teachers. Also well thought out internship programs can greatly improve the preparation of our teachers to meet the diverse needs of the Gen Z and Gen Alpha students. This paper looks at the value of including global issues, practical knowledge of child psychology, and ethical and social issues into the content of the teacher training curricula via robust internship experiences. Also, we put forth what we think are practical suggestions for the design of these internships that stress the importance of a well-balanced approach of structure, mentoring and real-world interaction to the future of our education system.

Key Words: *Teacher Education, Internships, Generation Z and Alpha, NEP-2020, Experiential Learning, Digital Pedagogy*

Introduction

The field of education is evolving rapidly, shaped by new generations, technological advancements, and shifting societal needs. Gen Z and Gen Alpha students bring

unique learning preferences, emphasizing digital fluency, personalized education, and experiential learning. As a result, teacher education programs must not only equip educators with subject knowledge but also prepare them for the dynamic, multifaceted role of modern teaching. NEP 2020 and NCF-SE has come up with global perspectives. These perspectives need to become part of teacher education curriculum. Theory and practical needs to be closely associated in any training program. One crucial way to achieve this is by enhancing internship experiences and integrating practical, real-world applications into training programs. Internships provide teacher trainees with hands-on experience that bridges the gap between theoretical knowledge and practical classroom dynamics. Well-structured internship programs can significantly impact teacher preparedness, fostering adaptability, confidence, and skill development.

Exposure to Real Classroom Environment teaches aspiring educators how to handle students effectively. Internships expose future teachers to different classroom structures, teaching methodologies, and student behaviours. They gain first-hand experience in lesson planning, classroom management, and communication strategies. Modern classrooms rely heavily on technology, from interactive whiteboards and AI-driven learning tools to personalized online platforms. Internships provide trainees with the opportunity to experiment with digital tools, understand their effectiveness, and learn best practices for incorporating technology into teaching. NEP 2020 has suggested various active learning pedagogies which needs to be experimented in the classrooms. Internships are like living laboratories for active learning pedagogies. It provides a stage for transition from passive teaching to intentional learning through active reflective thinking by the prospective teacher. Shadowing seasoned teachers, participating in peer discussions and receiving constructive feedback helps future educators refine their teaching styles. These interactions also encourage the exchange of innovative ideas that make classrooms more inclusive and engaging. Due to long duration of internship, it is an opportunity to practice interdisciplinary approaches in the form of projects, assignments and experiments.

Practical Understanding of Student Psychology is gained during internships. Internships allow teacher trainees to observe and engage with diverse learners, including students with special educational needs, gifted learners and those requiring individualized instruction. This exposure helps educators develop empathy, patience and adaptability—critical qualities for handling Gen Z and Gen Alpha students, who

have distinct emotional and cognitive needs. “One size fit to all” concept is relooked by the personal experience. Internships teach aspiring educators how to handle challenging classroom situations, such as student conflicts, behavioural issues, and classroom disruptions. Through direct engagement, trainees develop critical thinking and problem-solving skills, ensuring they can manage real-life classroom challenges effectively. This tenure in school is a boon to understand parent’s mindset through PTM.

Ethical and Social Responsibility through internships in teacher education is a powerful bridge between theory and practice—where aspiring educators not only refine their teaching skills but also engage deeply with the ethical and civic dimensions of education. Core objectives for this practice is community engagement and reflection practice. Every teacher education institute should identify well defined time period and activities during the internship. This practice builds professional identity rooted in empathy and civic responsibility and encourages critical thinking about social issues like inequality, sustainability, and access to education. Internships foster collaborative skills through interaction with students, teachers and local communities.

Making internships more effective in teacher education institute requires a thoughtful blend of structure, mentorship, and real-world engagement. Internships have to be a learning school to sharpen observation skills and reflective thinking of prospective teacher. Following are few actionable inputs to be considered while designing internships:

- Define specific learning outcomes for each phase of the internship—lesson planning, classroom management, community engagement, etc.
- Use individual development plans (IDPs) to track progress and personalize growth.
- Pair interns with trained mentor teachers who provide regular, constructive feedback. Make sure that trainees are functioning as shadow teachers regularly.
- Incorporate peer observation and video-based self-reflection to deepen pedagogical insight.
- Rotate interns across different school types (urban, rural, inclusive) to broaden exposure.

- Include community-based projects to foster social responsibility—like reading drives, environment campaigns, digital literacy, cyber security, cleanliness drives, skill enhancement or sustainability workshops.
- Use rubrics that assess both hard and soft skills, co-developed with partner schools.
- Align internship tasks with coursework—e.g., applying educational psychology in lesson design.
- Host weekly online sessions for reflection where interns connect fieldwork with academic theory.
- Encourage use of digital portfolios to document experiences and showcase growth.
- Give them task to experiment at least three different pedagogies and prepare reflection report.
- Design objective-based project related to inclusive education.
- College should develop MOOC course for students as per the local needs. Allot microcredits to varying task in internship. Encourage trainees to attend at least two webinars and complete one MOOC.
- Encourage trainees to construct various types of TLR and formative assessment tools. Ask them for try outs and a reflection report.

Teacher Education is the backbone of education system. It doesn't just shape teachers but it shapes the future of every student they'll ever teach. Every perspective of societal development is interwoven with teacher education. Hence each strand of teacher education needs to be perfectly interlaced to realise the dream vision of NEP 2020.

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Scope of Integrating AI in Teacher Education Instruction in India

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Abstract

The integration of Artificial Intelligence (AI) in Teacher Education in India represents a transformative opportunity to modernize teaching practices and overcome persistent challenges in the education sector. This paper provides a comprehensive analysis of the historical evolution, current applications, and potential benefits of AI in enhancing teacher education. AI technologies, including intelligent tutoring systems (ITS), personalized learning platforms, and AI-powered assessments, are reshaping traditional teacher training methods by offering adaptive learning paths, real-time feedback, and data-driven decision-making. These advancements enable educators to deliver more personalized and effective training to teacher trainees across diverse contexts, including urban and rural settings.

Government initiatives, such as the National Education Policy (NEP) 2020 and projects like DIKSHA and SWAYAM, have been pivotal in promoting AI adoption by providing digital infrastructure and accessible learning resources. Collaborative efforts with global technology leaders have further accelerated AI integration, offering scalable and cost-effective solutions for teacher education institutions. However, challenges such as financial limitations, digital infrastructure deficits, resistance to AI adoption, and concerns about data privacy pose significant barriers. The paper highlights the need for a multi-stakeholder approach involving policy reforms, enhanced funding mechanisms, targeted AI literacy programs for educators, and robust ethical guidelines to address these challenges effectively.

Keywords: *Artificial Intelligence, Teacher Education, Virtual Learning, Digital Infrastructure, Ethical Challenges*

1. Introduction

The integration of Artificial Intelligence (AI) in Teacher Education in India offers a transformative approach to addressing persistent challenges in the education system. This section examines the historical development, current state of AI integration, its potential benefits, and the challenges hindering its widespread adoption.

The journey of AI in India's education sector began in the early 2000s with the introduction of computer-based learning and digital literacy initiatives. The launch of the National Mission on Education through ICT (NMEICT) in 2009 marked a significant milestone, aiming to bridge the digital divide and enhance the quality of education through technology. This initiative laid the foundation for integrating AI tools in teacher education by promoting online learning platforms and digital resources. The adoption of AI accelerated post-2015 with the Digital India campaign, which emphasized the use of emerging technologies to improve education accessibility and quality. The establishment of AI research institutes and funding for AI-based educational projects further catalyzed this transformation.

The National Education Policy (NEP) 2020 has recognized AI as a key driver for transforming education in India. It advocates for the use of AI in personalized learning, assessment, and administration. Initiatives such as DIKSHA (Digital Infrastructure for Knowledge Sharing) and SWAYAM have begun incorporating AI to enhance the accessibility and quality of teacher training. Additionally, partnerships with technology giants like Google, Microsoft, and IBM have facilitated the deployment of AI-based tools for classroom management and real-time feedback.

Despite these advancements, significant challenges impede the effective integration of AI in teacher education. Financial constraints are a primary barrier, particularly for institutions in rural and low-resource settings. Moreover, the digital divide continues to limit access to AI-driven resources, especially in remote areas. A survey conducted by the Ministry of Education (2022) revealed that over 60% of teacher training institutions in rural India lack adequate infrastructure to support AI technologies. Furthermore, concerns about data privacy and ethical use of AI highlight the need for robust policy frameworks.

Addressing these challenges requires a multi-stakeholder approach involving government agencies, educational institutions, and private sector partnerships. Enhanced funding, targeted AI literacy programs for educators, and policies ensuring ethical AI use are crucial for sustainable AI integration. Moreover, adopting open-source AI tools could reduce costs and improve accessibility. Research collaborations focusing on localized AI solutions can further support the effective adoption of AI in teacher education.

Teacher education is essential for improving the quality of education and preparing future generations to thrive in a rapidly changing world. It equips educators with the

skills, knowledge, and methods needed to handle diverse classrooms. However, traditional teacher education programs often struggle to keep up with fast-paced technological advancements. Integrating Artificial Intelligence (AI) into teacher education offers a way to bridge this gap. AI tools can improve teaching quality, personalize learning, and streamline administrative tasks.

AI has the potential to transform teacher training by offering personalized learning paths for trainees, simplifying assessment processes, and encouraging reflective practices through intelligent data analysis. AI-powered simulations also allow trainees to gain practical experience by recreating real-world teaching scenarios. The importance of teacher education and evolution of AI in education is discussed as follows -

Importance of Teacher Education :Quality teacher education is the backbone of any effective education system. It helps educators develop the skills needed to foster creativity, critical thinking, and teamwork in students. Effective teacher education programs prepare trainees to handle a wide range of challenges, including different learning needs and behavioral management. AI can significantly enhance traditional teacher education by introducing innovative tools that support personalized learning. For example, AI systems can assess individual progress, identify areas for improvement, and provide customized resources. AI also supports the development of essential teaching skills, such as lesson planning and classroom management, through simulations and real-time feedback. Additionally, AI-enabled teacher education programs promote lifelong learning by providing access to micro-credentials and certifications. This ensures that educators can continuously update their skills and stay current with new teaching methods. Integrating AI into teacher education helps prepare educators to manage modern classrooms effectively.

Evolution of AI in Education :AI's role in education has expanded greatly over the years. Initially, AI was mainly used for administrative tasks like grading and managing attendance. These early systems relied on basic, rule-based algorithms. With advancements in machine learning and natural language processing, AI applications have become more advanced. Today, AI can personalize learning, provide real-time feedback, and simulate complex teaching situations. (Kim et al., 2023) Intelligent Tutoring Systems (ITS), for example, offer personalized guidance to trainees based on their unique needs. Similarly, AI-based platforms like Coursera and Duolingo adjust content delivery according to each learner's progress. AI in teacher

education has also grown to include immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR). These technologies allow trainees to practice teaching in simulated environments and receive immediate feedback. AI-powered analytics provide valuable insights into trainee performance, helping them refine their teaching methods. The evolution of AI in education marks a shift from traditional, one-size-fits-all approaches to more flexible, learner-centered models. Embracing AI technologies can help teacher education programs equip educators with the skills they need to thrive in modern classrooms. This approach promotes innovation, inclusivity, and a culture of continuous learning.

2. Applications of AI in Teacher Education

The integration of Artificial Intelligence (AI) into Teacher Education in India is gradually transforming traditional teaching methodologies. AI-based platforms like DIKSHA and SWAYAM, initiated by the Government of India, are playing a crucial role in making personalized learning accessible to a broad spectrum of educators. These platforms utilize AI algorithms to recommend resources based on individual learning patterns, ensuring that teacher trainees can access content that aligns with their learning needs and preferences. Additionally, the use of AI-driven intelligent tutoring systems (ITS) in these platforms helps in providing real-time feedback, which is essential for continuous professional development. Moreover, AI-powered assessments are being piloted in various states under the National Education Policy (NEP) 2020 to enhance objectivity and efficiency in teacher evaluations. AI tools are also being tested for streamlining administrative tasks in teacher education institutions, such as attendance tracking and performance analysis, to allow educators to focus more on teaching quality. However, challenges such as the digital divide, especially in rural areas, limit the widespread adoption of these technologies.

The integration of Artificial Intelligence (AI) into teacher education is revolutionizing how educators are trained and supported. AI offers a range of tools that enhance both learning and administrative processes, making teacher education more efficient and tailored to individual needs. From personalized learning experiences that adapt to trainees' unique learning patterns to AI-driven assessment tools that ensure objective and consistent feedback, AI addresses various aspects of teacher preparation. Additionally, intelligent tutoring systems (ITS) provide customized mentorship, helping trainees refine their teaching strategies based on real-time data analysis. AI

also extends to immersive technologies like Virtual Reality (VR) and Augmented Reality (AR), creating realistic teaching simulations that bridge the gap between theory and practice. Moreover, AI simplifies administrative tasks, allowing educators to focus more on teaching quality. As AI continues to evolve, its applications in teacher education promise to make the training process more inclusive, efficient, and responsive to the demands of modern classrooms. The applications of AI in teacher education are elaborated further.

Personalized Learning for Teacher Trainees :AI-powered platforms can analyze individual learning patterns, offering personalized content and feedback to teacher trainees. These systems provide adaptive learning experiences that cater to the unique needs of each learner. For example, AI systems like DreamBox Learning and Smart Sparrow create customized lesson plans, ensuring that teacher trainees receive content that matches their skill levels and learning preferences (Johnson et al., 2020). Launched by the Ministry of Education, DIKSHA is an AI-powered platform in India that provides personalized learning paths for teachers in multiple languages. It uses AI algorithms to recommend resources based on individual performance and needs. The platform's analytics help educators identify areas for improvement effectively. The National Digital Library of India (NDLI) uses AI to curate and recommend resources based on user preferences and learning patterns. Its AI-driven search and recommendation systems have been effective in helping teachers find relevant teaching materials quickly. Furthermore, personalized learning extends beyond content delivery to include skill development in classroom management and pedagogy. AI-powered simulation tools like Mursion allow trainees to practice teaching in virtual environments, providing immediate feedback on their performance, helping to build confidence and competence (Singh & Patel, 2022; Hernandez et al., 2023).

Intelligent Tutoring Systems (ITS) :Intelligent Tutoring Systems (ITS) simulate personalized mentorship for teacher trainees by using AI algorithms to guide and evaluate their performance. These systems employ natural language processing and machine learning to assess lesson plans, teaching strategies, and classroom simulations. For example, systems like Carnegie Learning and ALEX (Adaptive Learning Experience) provide actionable feedback on teaching practices and suggest evidence-based strategies for improvement (Brown et al., 2021; Chen & Wang, 2023). ITS also support reflective practices by encouraging trainees to analyze their teaching methods critically. Through real-time data collection and analysis, ITS offer a detailed

understanding of strengths and weaknesses, fostering professional growth (Li et al., 2022).

AI-Enhanced Assessment :AI tools streamline the assessment process by automating the evaluation of teaching simulations, lesson plans, and academic reflections. These tools ensure consistency and objectivity, eliminating biases that might occur in manual evaluations. Platforms like Gradescope and Turnitin employ AI algorithms to analyze assignments, detect plagiarism, and provide constructive feedback, enhancing the integrity of teacher education programs (Smith et al., 2022). Moreover, AI-powered assessment systems support formative evaluation by providing real-time feedback during teaching practice sessions (Garcia & Bennett, 2021). This allows trainees to make immediate adjustments to their strategies, promoting a cycle of continuous improvement. In India, SWAYAM integrates AI to offer MOOCs (Massive Open Online Courses) for teachers, featuring adaptive assessments and real-time feedback mechanisms. The platform's AI-driven analytics track teacher progress and suggest personalized content, making it effective for continuous professional development.

Virtual Reality (VR) and Augmented Reality (AR) Integration :AI enhances VR and AR technologies by creating immersive learning environments for teacher trainees. These technologies simulate real-world classroom scenarios, enabling trainees to practice teaching strategies in a risk-free setting. For instance, VR platforms like TeachLivE offer AI-powered simulations where trainees can interact with virtual students, sharpening their classroom management and instructional skills. AR applications, such as those used in interactive lesson design, help trainees visualize complex concepts and develop engaging teaching materials. AI-driven analytics within these platforms track trainee performance, providing insights into areas that require further development. This combination of AI, VR, and AR fosters experiential learning, bridging the gap between theoretical knowledge and practical application (Lee & Kim, 2023; Robinson et al., 2023).

Streamlining Administrative Tasks :AI-driven systems reduce the administrative burden on teacher educators by automating tasks such as scheduling, attendance tracking, and resource management. Tools like AI-powered learning management systems (LMS) facilitate seamless communication between trainees and educators, ensuring efficient course management. For example, platforms like Canvas and Blackboard integrate AI functionalities to monitor trainee engagement and predict

potential challenges. These insights enable educators to intervene proactively, supporting trainee success. Implemented in Rajasthan, India, ShalaDarpan uses AI for administrative tasks like attendance tracking, performance analysis, and data management in schools. Its AI-driven insights help school administrators make data-driven decisions, reducing administrative workload on educators. Additionally, AI chatbots assist in resolving administrative queries, providing round-the-clock support for trainees. Streamlining these processes allows educators to focus on delivering high-quality instruction and mentoring, ultimately enhancing the overall effectiveness of teacher education programs (Miller et al., 2022; Davis & Clark, 2023).

3. Benefits of AI Integration in Teacher Education

The benefits of integrating AI in Teacher Education in India are significant, particularly in enhancing accessibility and personalized learning. AI-based tools such as Google's Bolo and Microsoft's AI-powered translation services are helping to break down language barriers, making educational content accessible to teachers in multiple regional languages. Additionally, the use of adaptive learning platforms under DIKSHA has demonstrated improvements in teacher competency by providing targeted resources based on real-time performance analytics. AI also supports data-driven decision-making in teacher education by offering insights into trainee progress and identifying areas that require intervention. AI-driven analytics used in platforms like ShalaDarpan enable educators to make informed decisions regarding curriculum adjustments and resource allocations. However, addressing challenges such as financial constraints and limited AI literacy among educators is essential to maximize these benefits.

The integration of Artificial Intelligence (AI) in teacher education offers significant benefits that enhance both learning and teaching experiences. AI tools can personalize learning paths for teacher trainees, helping them focus on areas that need improvement and ensuring better learning outcomes. By analyzing performance data, AI systems provide detailed feedback that supports trainees in developing their skills effectively. Additionally, AI improves accessibility by offering tools like text-to-speech, real-time translation, and adaptive streaming, making education more inclusive for trainees with diverse needs. Data-driven decision-making powered by AI helps educators design more effective training programs and monitor trainee progress

in real-time. AI also supports lifelong professional development by recommending courses and providing continuous feedback. By embracing AI technologies, teacher education programs can create a more adaptive, inclusive, and efficient learning environment that prepares educators to meet the challenges of modern classrooms. The benefits are elaborated further.

Enhanced Learning Outcomes :AI-powered tools have a profound impact on improving learning outcomes for teacher trainees by providing precise, actionable insights into their performance. Unlike traditional assessment methods, AI-driven systems identify specific areas where trainees excel or require additional support. For instance, platforms like Gradescope and Adaptive Learning Technology Solutions provide detailed analytics, enabling trainees to focus on weaker areas (Smith et al., 2022). This individualized feedback fosters a deeper understanding of pedagogical concepts, equipping trainees with the skills to address diverse classroom challenges effectively. Simulations powered by AI further enhance learning outcomes by immersing trainees in real-life teaching scenarios. These simulations use machine learning algorithms to replicate complex classroom dynamics, allowing trainees to practice and refine their teaching strategies without the risk of real-world consequences (Hernandez et al., 2023). Real-time feedback in these environments accelerates skill development and builds confidence among trainees. Moreover, AI facilitates collaborative learning by connecting trainees with peers and mentors through intelligent networking platforms. AI-driven tools recommend study groups, online forums, and peer review systems that align with a trainee's interests and objectives, promoting a culture of shared learning and continuous improvement (Garcia & Bennett, 2021). By integrating AI, teacher education programs foster a robust learning ecosystem that prioritizes individual growth and collective excellence.

Accessibility Improvements :One of the most transformative aspects of AI integration in teacher education is its ability to enhance accessibility for diverse learners. AI-powered tools such as text-to-speech converters, language translation applications, and voice recognition software enable trainees with disabilities to engage effectively with educational content (Kim et al., 2023). For example, Google's Live Transcribe and Lookout applications ensure visually and hearing-impaired trainees can actively participate in learning activities. AI also addresses language barriers in multicultural classrooms by providing real-time translation services. Tools like Microsoft Translator and Google Translate allow trainees from different linguistic

backgrounds to collaborate seamlessly, fostering inclusivity in teacher education programs. This is particularly vital in global training initiatives where language diversity often poses challenges (Chen & Wang, 2023). Remote learning is another area where AI greatly improves access to education. By using adaptive streaming technologies, AI allows trainees in areas with limited internet to access high-quality learning materials without significant delays or interruptions. This is particularly beneficial for remote and underserved regions where stable internet connections are rare. AI-powered platforms also offer flexible schedules and self-paced modules, enabling trainees to progress at their own speed, regardless of time zone or personal commitments (Davis & Clark, 2023). Additionally, AI systems can translate and customize content to suit different linguistic and cultural backgrounds, further enhancing accessibility. These advancements make teacher education more inclusive and equitable, providing opportunities for trainees from diverse backgrounds to thrive in their professional development.

Data-Driven Decisions :AI enables data-driven decision-making in teacher education, revolutionizing how programs are designed, implemented, and assessed. Advanced analytics tools like Tableau and Power BI make use of AI algorithms to process vast amounts of data, providing actionable insights into trainee performance and program effectiveness (Williams et al., 2023). These insights allow educators to create training modules to address the specific needs of individual trainees for optimizing the learning experience. AI also supports real-time monitoring of trainee engagement, attendance, and progress. For instance, learning management systems (LMS) like Blackboard and Canvas integrate AI to identify at-risk trainees early and recommend targeted interventions. This proactive approach ensures that trainees receive timely support, improving retention rates and learning outcomes (Miller et al., 2022). AI-driven data analytics also help institutions evaluate the success of their teacher education programs. Metrics such as trainee satisfaction, teaching proficiency, and employment rates provide a comprehensive understanding of program impact, guiding future improvements. By using data-driven insights, AI empowers educators to make informed decisions that improve the quality and relevance of teacher training.

Lifelong Professional Development :AI plays a pivotal role in fostering lifelong professional development among educators. Platforms like LinkedIn Learning, Udemy, and Coursera use AI algorithms to recommend courses and certifications that align with individual career aspirations and skill gaps. These platforms offer micro-

credentials in areas such as classroom management, inclusive education, and digital literacy, enabling educators to stay updated with evolving pedagogical practices (Singh & Patel, 2022). AI also enhances reflective practices by analyzing teaching portfolios and providing personalized feedback. Tools like Edthena and GoReact utilize AI to evaluate recorded teaching sessions, highlighting areas for improvement and suggesting actionable strategies. This continuous feedback loop encourages educators to refine their skills and adopt innovative teaching methodologies (Garcia & Bennett, 2021). Mentorship and networking opportunities are further amplified by AI. Intelligent platforms connect educators with mentors and peers worldwide, facilitating knowledge exchange and collaborative growth. These networks foster a culture of lifelong learning, ensuring that educators remain adaptable and resilient in the face of changing classroom dynamics (Kim et al., 2023). By integrating AI into professional development, teacher education programs create a sustainable framework for continuous improvement and excellence.

4. Challenges in Integrating AI in Teacher Education

The integration of AI in teacher education in India faces significant challenges, primarily due to financial constraints and infrastructural limitations. A survey by the Ministry of Education (2022) indicated that over 60% of teacher training institutions in rural India lack the digital infrastructure necessary to support AI technologies. The high cost of AI tools, coupled with limited funding under schemes like SamagraShikshaAbhiyan, further complicates adoption efforts. Moreover, the digital divide continues to be a substantial barrier, with many regions lacking access to high-speed internet essential for AI-powered platforms. Ethical concerns related to data privacy and algorithmic bias also present challenges. As AI systems collect vast amounts of data, ensuring compliance with data protection regulations such as the Information Technology Act (2000) is crucial. Establishing clear guidelines and conducting regular audits can help mitigate these risks. Additionally, enhancing AI literacy among educators through targeted training programs is essential for effective integration.

Integrating Artificial Intelligence (AI) into teacher education presents several challenges that need careful consideration. One major concern is data privacy. AI systems collect large amounts of personal information and performance data from

trainees, raising risks of data breaches and misuse if proper safeguards are not in place. Financial barriers also pose significant challenges, as acquiring AI tools, maintaining infrastructure, and training staff require substantial funding. Smaller institutions, especially in low-resource settings, often struggle to afford these costs. Additionally, resistance to change is a common issue among educators and trainees who fear that AI might replace human roles in teaching or be too complex to use. Building awareness and providing hands-on training can help overcome these concerns. Infrastructure limitations, especially in developing regions, further complicate AI adoption. Addressing these challenges requires a collaborative effort between governments, educational institutions, and technology providers to create sustainable solutions. The aforementioned challenges are discussed further.

Ethical Considerations :The integration of AI into teacher education raises significant ethical considerations that demand careful attention. Chief among these is the issue of data privacy. AI systems collect and process vast amounts of data on trainees, including personal information and performance metrics. Without robust safeguards, this data is vulnerable to breaches and misuse, potentially compromising the privacy of individuals and reducing trust in educational institutions (Zhao & Chen, 2023). Legal frameworks such as General Data Protection Regulation (GDPR) and Family Educational Rights and Privacy Act (FERPA) provide guidelines for data protection, but their application to AI-specific contexts in education often lacks clarity.

Financial Barriers :The adoption of AI technologies in teacher education requires significant financial investment, presenting challenges for institutions with limited budgets. Acquiring AI-powered tools, maintaining infrastructure, and training staff to use these technologies effectively all involve substantial costs. Smaller institutions and those in low-resource settings often struggle to secure the necessary funding for such initiatives (Davis & Clark, 2023). One potential solution is exploring public-private partnerships. Collaborations with technology providers can reduce costs by offering subsidized access to AI platforms and resources. Additionally, government grants and international funding programs targeted at educational innovation can provide financial support to institutions adopting AI. Open-source AI tools represent another cost-effective alternative. Platforms such as TensorFlow and PyTorch enable institutions to develop and customize AI applications without incurring high licensing

fees. Sharing resources among institutions through collaborative networks can further mitigate financial constraints, enabling broader access to advanced technologies.

Resistance to Change :Resistance to adopting AI in teacher education is a common challenge, rooted in fear, skepticism, and a lack of familiarity with technology. Educators may worry that AI will replace their roles or diminish the importance of human interaction in teaching. Trainees, on the other hand, might be apprehensive about engaging with complex technologies they perceive as difficult to understand (Smith et al., 2022). Addressing these concerns requires comprehensive awareness campaigns that highlight the benefits of AI as a complementary tool rather than a replacement for educators. Demonstrating successful case studies where AI has enhanced teaching and learning outcomes can alleviate fears and build confidence in its potential (Kim et al., 2023). Providing hands-on training and professional development opportunities can empower educators and trainees to use AI effectively. Peer mentoring programs and collaborative workshops can foster a supportive environment where individuals feel confident experimenting with new technologies. Encouraging active participation in the design and implementation of AI systems ensures that stakeholders feel invested in the integration process.

Infrastructure Needs :A robust digital infrastructure is fundamental for implementing AI in teacher education. Essential components include high-speed internet, modern computing devices, and reliable power supply. However, many regions, particularly in developing countries, face significant gaps in these areas, limiting their ability to adopt AI technologies effectively (Garcia & Bennett, 2021). Governments and international organizations play a critical role in addressing these challenges. Investments in digital infrastructure, such as broadband expansion projects and subsidized technology programs, can bridge the digital divide and enable equitable access to AI-powered education. Initiatives like the Global Connectivity Alliance aim to provide affordable internet access to underserved regions, ensuring that no institution is left behind. Efforts to bridge this infrastructure gap in India is being addressed by the BharatNet project which aims to provide high-speed broadband to rural areas, enabling the use of AI-driven tools in remote teacher education programs. It has been instrumental in expanding the reach of AI-based platforms like DIKSHA and SWAYAM to rural educators. Developing offline AI applications and low-bandwidth solutions can also address infrastructure limitations. These technologies allow institutions with limited connectivity to benefit from AI

advancements without requiring constant internet access. Collaboration among educational institutions, technology providers, and policymakers is essential to create scalable and sustainable solutions that support AI integration across diverse contexts.

5. Future Directions and Recommendations

The future of AI in teacher education in India will depend heavily on robust policy frameworks and multi-stakeholder collaborations. Strengthening policies in line with the Draft National Strategy for AI by NITI Aayog, which emphasizes ethical AI use and data privacy, is crucial. Enhanced funding mechanisms, including public-private partnerships and international grants, can help address financial challenges. Investing in AI literacy programs for educators is equally important. Training modules focusing on AI applications in classroom management, personalized learning, and assessment can empower educators to utilize AI tools effectively. Additionally, adopting open-source AI platforms can significantly reduce costs and improve accessibility, particularly for low-resource institutions. Collaboration with AI research institutes in India, such as IITs and IISc, can facilitate the development of localized AI solutions tailored to the diverse educational needs of the country.

The future of integrating Artificial Intelligence (AI) in teacher education depends on well-planned strategies and collaborations. Effective policy development is crucial to address ethical challenges such as data privacy, algorithm fairness, and accountability in AI use. Clear policies can ensure that AI tools are used transparently and fairly. Governments and educational institutions must work together to create incentives like subsidies and grants to support AI adoption. Collaborating with technology providers is also essential. Such partnerships can lead to AI solutions that are practical, scalable, and aligned with classroom needs. Training educators in AI literacy is equally important to help them confidently use AI tools in teaching. Additionally, global research initiatives can help understand AI's impact on education across different cultures. By focusing on these areas, teacher education can harness AI's full potential to improve teaching and learning outcomes.

Policy Development :Policy development is essential to ensure the successful integration of AI in teacher education. Comprehensive policies must address ethical concerns, such as data privacy, algorithmic fairness, and accountability in AI decision-making. Frameworks like GDPR in Europe and FERPA in the U.S. provide

initial guidelines, but more specific policies tailored to education are needed. These should emphasize transparent AI use and prioritize equitable access to AI tools for underrepresented communities. Governments and educational institutions must collaborate on creating incentives for AI adoption. Subsidies for AI implementation, tax breaks for institutions adopting innovative technologies, and grants for AI-related research can drive progress. Additionally, national and international coalitions can facilitate the sharing of resources and best practices. For example, partnerships with organizations such as the OECD and UNESCO can align global educational standards (Chen et al., 2023). Policymakers should also establish monitoring mechanisms to evaluate the impact of AI technologies on teacher education. Regular assessments can ensure that AI applications align with educational goals, maintain ethical standards, and deliver measurable improvements in trainee outcomes. Such proactive policy frameworks will enable the integration of AI to be both sustainable and impactful.

Collaboration with Technology Providers : Collaboration with technology providers is crucial for tailoring AI solutions to the unique needs of teacher education. These partnerships enable co-creation of tools designed to meet pedagogical objectives. For example, companies like Google and Microsoft have collaborated with educational institutions to provide AI-powered solutions for classroom management and assessment (Garcia & Bennett, 2021). Technology providers can also offer support through training programs that enhance educators' technological proficiency. Subsidized access to advanced tools can help resource-constrained institutions adopt AI technologies. Co-development agreements, where providers and educators collaborate on tool creation, ensure that AI applications are intuitive, effective, and aligned with classroom realities (Miller et al., 2022). Additionally, technology providers must prioritize the scalability of their solutions. AI platforms must cater to institutions of varying sizes and resources. Open-source AI models can address scalability concerns, allowing institutions to customize applications without significant financial investment. Such collaborations strengthen the educational ecosystem by integrating cutting-edge technology with practical teaching needs.

Training for Educators : Training educators in AI literacy is a critical step for successful implementation. Comprehensive training programs should encompass technical proficiency, ethical AI use, and practical applications of AI in the classroom. This ensures that educators are not only adept at using AI tools but also confident in their ability to integrate these technologies into teaching practices (Kim

et al., 2023). Workshops, online courses, and certifications tailored to educators' needs can accelerate AI adoption. For example, organizations like ISTE offer professional development programs that focus on digital competency and AI literacy. Peer mentoring programs, where tech-savvy educators guide their colleagues, can create a collaborative learning environment and address resistance to change (Chen et al., 2023). Continuous professional development is equally important. Institutions should provide opportunities for educators to stay updated on AI advancements. By fostering a culture of lifelong learning, teacher education programs can ensure that educators remain adaptable and prepared to meet evolving classroom demands.

Global Research Initiatives :Global research initiatives are vital to advancing AI integration in teacher education. Collaborative studies can explore the cultural implications of AI in diverse educational contexts, identifying best practices for inclusive implementation. Partnerships among universities, government agencies, and international organizations like UNESCO can create a global knowledge base that addresses the nuances of AI adoption. Research priorities should include evaluating the long-term impact of AI on teaching efficacy, exploring ethical concerns, and developing adaptive AI models that cater to different learning environments. Additionally, studies on infrastructure requirements and cost-effective solutions can guide policymakers and institutions in overcoming implementation barriers (Davis & Clark, 2023). Sharing research findings through open-access platforms can democratize knowledge and enable institutions worldwide to benefit from collective advancements. These initiatives not only promote equity in AI integration but also foster innovation, ensuring that teacher education remains relevant in a rapidly evolving technological landscape.

Conclusion

The integration of Artificial Intelligence (AI) into teacher education is reshaping the landscape of educational methodologies and practices in India. By incorporating AI-driven tools and strategies, teacher education programs can become more dynamic, personalized, and effective. However, achieving this transformation requires a balanced approach that addresses both opportunities and challenges, particularly in the Indian context.

The potential benefits of AI in teacher education are profound. Personalized learning experiences allow teacher trainees to progress at their own pace, focusing on areas where they need the most improvement. Intelligent Tutoring Systems (ITS), AI-enhanced assessments, and real-time analytics provide actionable insights that support skill development and foster continuous growth. Additionally, government initiatives such as DIKSHA and SWAYAM have begun integrating AI tools to enhance the accessibility and quality of teacher training, especially in rural and underserved areas. Collaborations with global technology leaders have also facilitated the deployment of AI-based tools for classroom management and personalized feedback.

Nevertheless, the challenges associated with AI integration cannot be overlooked. Ethical concerns, including data privacy and algorithmic bias, require stringent regulations and transparency measures. Financial barriers and infrastructural limitations are particularly significant in India, where the digital divide remains a major obstacle. Surveys indicate that a substantial percentage of teacher training institutions in rural India lack the infrastructure to support AI technologies. Addressing these challenges will require substantial investments in digital infrastructure, targeted AI literacy programs for educators, and clear policies ensuring data privacy and ethical AI use.

Looking forward, the successful implementation of AI in teacher education in India will depend on proactive policy development, robust collaboration with technology providers, and a focus on scalable and cost-effective solutions. Policies must address ethical considerations and promote equitable access to AI tools, while partnerships with industry stakeholders can drive innovation. Additionally, adopting open-source AI tools could reduce costs and improve accessibility for low-resource institutions.

In conclusion, AI has the potential to revolutionize teacher education in India by enhancing efficiency, accessibility, and instructional quality. By strategically addressing existing challenges and fostering partnerships between the government, educational institutions, and private sectors, AI can contribute significantly to building a more inclusive, responsive, and future-ready teacher education system.

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(Making Inclusive education penetrate in school classrooms through TEI)

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સારાંશ:

વર્તમાન સમયમાં શિક્ષણક્ષેત્રે ચર્ચા કરવા યોગ્ય કોઈ વિષય હોય તો તે છે રાષ્ટ્રીય શિક્ષણ નીતિ. જેનું લક્ષ્ય ભારત દેશના વિકાસ માટેની અનિવાર્ય જરૂરિયાત પૂર્તિ કરવાનું છે. આ જરૂરિયાતોની પૂર્તિ કરવા માટેનું અસરકારક પરિબળ હોય તો તે શિક્ષણ વ્યવસ્થા છે. કોઠારી પંચના મત અનુસાર “ભારતનું ભાવિ વર્ગખંડમાં ઘડાઈ રહ્યું છે.” વર્ગખંડનું ઘડતર એટલે વર્ગખંડના પ્રત્યેક બાળકની વિશિષ્ટ ક્ષમતાઓની સ્વીકૃતિ કરી તેને આગવી ઓળખ આપી તેના વિકાસ માટેનો પ્રયત્ન કરવો. NEP2020 ના પ્રકરણ-6 માં સમાવેશક શિક્ષણનો ઉલ્લેખ જોવા મળે છે. આવનાર સમયમાં વર્ગખંડમાં સમાવેશી શિક્ષણ જોવા મળશે આથી વર્તમાન સમયમાં પ્રશિક્ષણ આપતી તાલીમી સંસ્થાઓએ તાલીમ લેતા પ્રશિક્ષણાર્થીમાં સમાવેશક શિક્ષણ અંગે સજ્જતા કેળવવી પડશે. પ્રસ્તુત પ્રકરણમાં NEP 2020માં સમાવેશક શિક્ષણનું સ્થાન, ભારત દેશની આ સંદર્ભે સ્થિતિ, અક્ષમતાનો અર્થ અને પ્રકાર, પ્રશિક્ષણાર્થીની અક્ષમતા અંગેની સભાનતા. વર્ગખંડની ભૂમિકા, વાલી સાથેનું પરામર્શન જેવા મુદ્દાની વિગતે ચર્ચા કરી છે. જેની જાણકારી આવનાર સમયમાં શિક્ષણ સાથે સંકળાયેલા તમામને ઉપયોગી બનશે.

ચાવીરૂપ શબ્દો: NEP-2020, સમાવેશક શિક્ષણ, પ્રશિક્ષણાર્થીની સજ્જતા

પ્રસ્તાવના:

ભારતીય સંસ્કૃતિ એટલે વેદોની સંસ્કૃતિ અને મૂલ્યોની સંસ્કૃતિ. મૂલ્યોનું પ્રતિપાદન કરતાં સુભાષિતો આપણી આગવી ઓળખ છે. માનવીય સંવેદના અને કરુણાનો સંદેશ આપતા સુભાષિતમાં કહેવાયું છે.

કૃશોપિ જાયતે હંસઃ પઙ્ગુરપિ ગિરિં લઙ્ઘયેત્।
અન્ધોઽપિ પશ્યતિ વસ્તૂનિ મનસા ન હિ દુર્બલઃ॥

અર્થાત્ (નબળો વ્યક્તિ પણ હંસની જેમ મહાન બની શકે છે. અપંગ વ્યક્તિ પણ પર્વતને પાર કરી શકે છે, અંધ માણસ પણ મનથી બધી વસ્તુઓને જોઈ શકે છે.(મનથી કોઈ દુર્બલ નથી.)

સમાવેશક શિક્ષણના અન્વયે આવો ઉલ્લેખ પણ જોવા મળે છે. સૃષ્ટિમાં જે કોઈ અપંગ,અંધ, દિવ્યાંગ વગેરે છે. તે બધા જ સામાજિક ધૃણાને પાત્ર નથી આપણે તેમની સાથે સહૃદયતા પૂર્વક માનવીય વ્યવહાર કરવો જોઈએ. સમગ્ર વિશ્વએ પણ સમાવેશક શિક્ષણને સ્વીકૃતિ આપી છે. વિશ્વના તમામ રાષ્ટ્રોમાં શિક્ષણથી વંચિત રહેતા બાળકો સહિત તમામ ધર્મ, લિંગ, વિવિધ સંપ્રદાયના બાળકો કોઈ પણ પ્રકારની અક્ષમતા ધરાવતા બાળકોને કોઈપણ પ્રકારના ભેદભાવ વિના શાળાની એક જ છત નીચે સમાન શૈક્ષણિક વાતાવરણમાં સમાન શિક્ષણ મળી રહે તેવી સ્વીકૃતિ ઊભી થઈ છે જેમાંથી સમાવેશક શિક્ષણની સંકલ્પના અસ્તિત્વમાં આવી. આ ઉપરાંત વિકલાંગોને શિક્ષણનો અધિકાર આપવા માટેના પ્રથમ પગલાં સ્વરૂપે સંયુક્ત રાષ્ટ્ર ધ્વારા 1981 થી 1992નો સમયગાળાને ‘વિકલાંગ વ્યક્તિઓના દસકા’ તરીકે જાહેર કરવામાં આવ્યો છે. 3 મે 2008ના રોજ ‘ વિકલાંગોના અધિકાર’ કરાર પત્ર પણ તૈયાર કરવામાં આવ્યો છે. 172 દેશમાં તેનું અમલીકરણ પણ શરૂ થયું છે ત્યારે ભારત દેશના વડાપ્રધાન શ્રી નરેન્દ્ર મોદી દ્વારા આકાશવાણી પર પ્રસારિત થતા ‘મન કી બાત’ કાર્યક્રમમાં 27 ડિસેમ્બર 2016 ના રોજ અક્ષમતા ધરાવતી વ્યક્તિને દિવ્યાંગ શબ્દ આપવામાં આવ્યો છે . વિકલાંગને જ્યારે દિવ્યાંગ શબ્દ મળ્યો છે ત્યારે શિક્ષણ વ્યવસ્થા સાથે સંકળાયેલા અને ભારતના ભવિષ્યને ઘડનાર પ્રશિક્ષણાર્થીની પણ સવિશેષ જવાબદારી બની જાય છે.

NEP 2020માં સમાવેશક શિક્ષણની સ્થિતિ:

આંતરરાષ્ટ્રીય ક્ષેત્રની સાથે ભારતમાં પણ સમાવેશક શિક્ષણના પ્રચાર અને પ્રસાર માટેના સઘન પ્રયાસો હાથ ધરવામાં આવ્યા છે. શિક્ષણની ગુણવત્તા સુધારણા માટે અને વર્તમાન સમયમાં સમગ્ર વિશ્વ સાથે કદમ મિલાવવા માટે Ministry of Human Resources Development, Government of India ધ્વારા NEP 2020ની શિક્ષણ નીતિ અમલમાં મૂકવામાં આવી. સમગ્ર શિક્ષણ નીતિને ચાર વિભાગમાં વિભાજિત કરવામાં આવી છે. જેનું નીચે પ્રમાણે વિભાગીકરણ કરવામાં આવ્યું છે.

વિભાગ 1	શાળા શિક્ષણ	પ્રકરણ 1 થી 8
વિભાગ 2	ઉચ્ચ શિક્ષણ	પ્રકરણ 9 થી 19
વિભાગ 3	અન્ય કેન્દ્રવર્તી શિક્ષણ ક્ષેત્રો	પ્રકરણ 20 થી 24
વિભાગ 4	અમલીકરણ વ્યૂહ રચના	પ્રકરણ 25 થી 27

આમ, શિક્ષણની ગુણવત્તા સુધારણા માટે સમગ્ર શિક્ષણનીતિ 27 પ્રકરણમાં વિભાજીત કરવામાં આવી છે. જેમાં વિભાગ 1. શાળા શિક્ષણના પ્રકરણ-6માં સમાન અને સર્વસમાવેશક શિક્ષણની પાના નંબર 24 થી 28 સુધી સમાવેશક શિક્ષણ સંદર્ભે વિસ્તૃત ચર્ચા કરવામાં આવી છે. ઉચ્ચ શિક્ષણમાં પણ સમાનતા અને સમાવેશન ખૂબ મહત્વનું છે. આ અંગે વિભાગ-2 પ્રકરણ 14 પાના નંબર 41 થી 42 માં વિગતે નોંધ કરવામાં આવી છે. જે અંગે પ્રકરણ- 6માં વિસ્તૃત વિગત નીચે પ્રમાણે જોવા મળે છે.

- U-DISE 2016-17 મુજબ દિવ્યાંગ વિદ્યાર્થીનો ઉચ્ચતર માધ્યમિક કક્ષાએ પ્રવેશ નોંધણી દર 1.1 થી 0.24 જોવા મળે છે. જે અતિ ગંભીર બાબત છે.
- દિવ્યાંગ બાળકોને અન્ય બાળકની જેમ ગુણવત્તાયુક્ત શિક્ષણ મેળવવાની સમાન તકો પૂરી પાડવા માટે સક્ષમ પદ્ધતિની રચના કરવાનું મહત્વ આપવામાં આવ્યું છે.
- ECCEના અન્વયે દિવ્યાંગ બાળકોના સમાવેશનને અગ્રતા આપવામાં આવશે.
- રાષ્ટ્રીય અભ્યાસક્રમ તૈયાર કરતી વખતે NCERT દિવ્યાંગજન વિભાગના રાષ્ટ્રીય સંસ્થાનો સાથે પરામર્શન કરશે.
- દિવ્યાંગ બાળકોની તાલીમ માટે વિશિષ્ટ શિક્ષકોની ભરતી કરવામાં આવશે એટલુંજ નહીં આ સંદર્ભે વિવિધ સંશોધન કરવામાં આવશે. તેમના માટે જરૂરી ઉપકરણો અને તકનીકી સાધનો પણ પૂરા પાડવામાં આવશે.
- NIOS ધ્વારા વિવિધ કલા ક્ષેત્રે ,રમતગમત અને વ્યવસાય ક્ષેત્રે દિવ્યાંગ બાળકો માટે વિવિધ મોડ્યુલ વિકસાવવામાં આવશે.
- તેમની સલામતી અને સુરક્ષા પ્રત્યે પૂરતું ધ્યાન આપવામાં આવશે.
- ગંભીર દિવ્યાંગ બાળકને ગૃહશિક્ષણની વ્યવસ્થા પૂરી પાડવામાં આવશે અને તેમના માતાપિતાને જરૂરી શિક્ષણ સામગ્રી આપવામાં આવશે.
- New Netional Assessment center,PARAKH ધ્વારા આ બાળકોના મૂલ્યાંકન માટેની માર્ગદર્શિકા ઘડવામાં આવશે.
- શિક્ષકોમાં આવા બાળકોને ભણાવવા માટેની જાગૃતિ લાવવામાં આવશે અને તેમણે સંવેદનશીલતાનું જ્ઞાન આપવામાં આવશે.

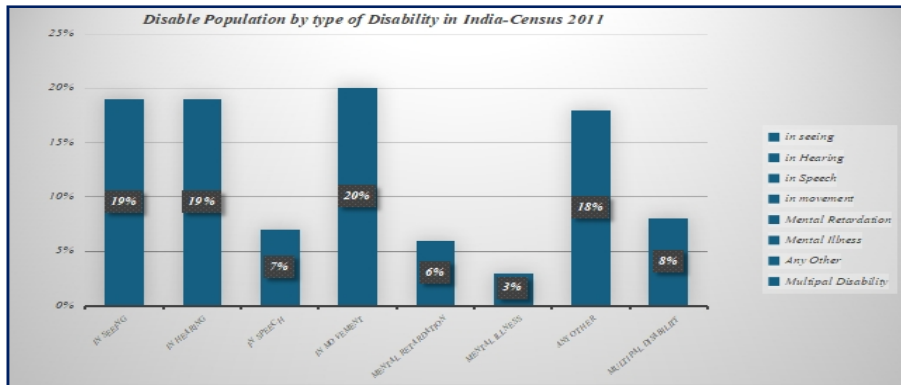
પ્રકરણ-14 માં નીચેની વિગતો જોવા મળે છે.

- ઉચ્ચ શિક્ષણમાં સમાનતા અને સમાવેશન માટે ફીમાં ઘટાડો કરવામાં આવશે.
- તેમને આર્થિક સહાય અને શિષ્યવૃત્તિ આપવામાં આવશે.

- અભ્યાસક્રમ અને પ્રવેશની પ્રક્રિયા વધુ સમાવેશી બનાવવામાં આવશે.
- તેમના માટે વિવિધ જરૂરી ભૌતિક સુવિધા કરવામાં આવશે.
- દિવ્યાંગ બાળકોને ગુણવત્તાયુક્ત શિક્ષણ મળી રહે તે માટે Bridge Courseની રચના કરવામાં આવશે.
- તેમના સામાજિક અને ભાવનાત્મક વિકાસ માટે વિશેષ માર્ગદર્શનની વ્યવસ્થા કરવામાં આવશે.

ભારતમાં સમાવેશક શિક્ષણની સ્થિતિ:

- સ્વતંત્રતા પછી ભારતમાં શિક્ષણનો વિકાસ ઝડપી થવા લાગ્યો. લોકોમાં શિક્ષણ પ્રત્યે વધુ જાગૃતિ આવી. ભારતમાં જન સંખ્યા પણ ખૂબ ઝડપથી વધવા લાગી. 2011માં થયેલી વસ્તી ગણતરી મુજબ ભારતમાં કુલ 2,68,14,9994 લોકો કોઈને કોઈ પ્રકારે અક્ષમતા ધરાવતા હતા. તે સમયે નેપાળની કુલ વસ્તી 2,66,20,809 અને શ્રીલંકા ની વસ્તી 2,08,69,000 એટલે કે આપણા પડોશી સ્વતંત્ર દેશની વસ્તી કરતા આપણા દેશમાં અક્ષમતા ધરાવતા લોકોની સંખ્યા વધારે હતી.
- Government of India PwD in India -A Statistical Profile:2021 ના રિપોર્ટના આંકડા મુજબ અક્ષમતા ધરાવતા લોકોની અક્ષમતા જોઈએ તો ભૌતિક મુજબનો ગ્રાફ જોવા મળે છે.



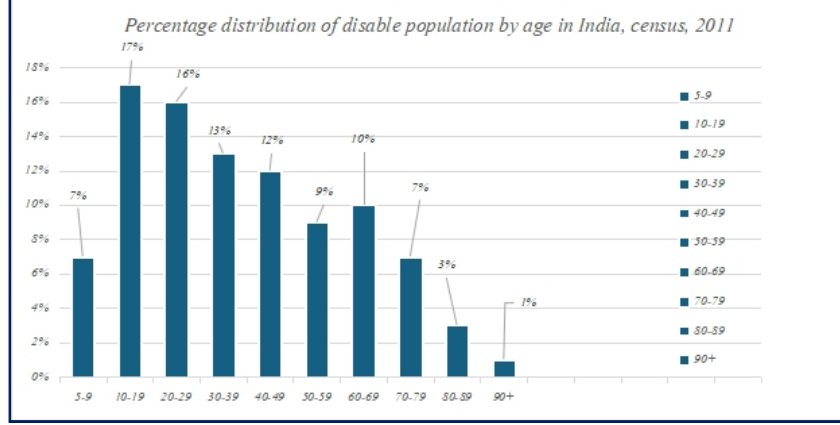
વિવિધ પ્રકારની અક્ષમતા ધરાવતી જન સંખ્યા

આલેખ-1

ઉપરના ગ્રાફમાં વિવિધ પ્રકારની 8 અક્ષમતાની ટકાવારીનું પ્રમાણ આપ્યું છે. જે મુજબ ભારત દેશની કુલ વસ્તીના પ્રમાણમાં 19% લોકો દ્રષ્ટિ અને સાંભળવાની અક્ષમતા ધરાવે છે જેનું પ્રમાણ ખૂબ મોટું છે. 7% લોકો બોલવાની અક્ષમતા ધરાવે છે. 20% લોકો હલનચલન અક્ષમતા

ધરાવે છે. 6% લોકો માનસિક મંદતા સાથે જોડાયેલા છે. 3% લોકો માનસિક બીમારીથી પીડાય છે. 18% લોકો અન્ય અક્ષમતા સાથે સંકળાયેલા છે જ્યારે 8% લોકો વિવિધ પ્રકારની અક્ષમતા ધરાવે છે. આમ, ભારત દેશની જન સંખ્યા મુજબ અક્ષમતાનું પ્રમાણ ઘણું વધારે છે.

અક્ષમતાની જનસંખ્યાના ઉંમર પ્રમાણે નીચે મુજબના આંકડા જોવા મળે છે.



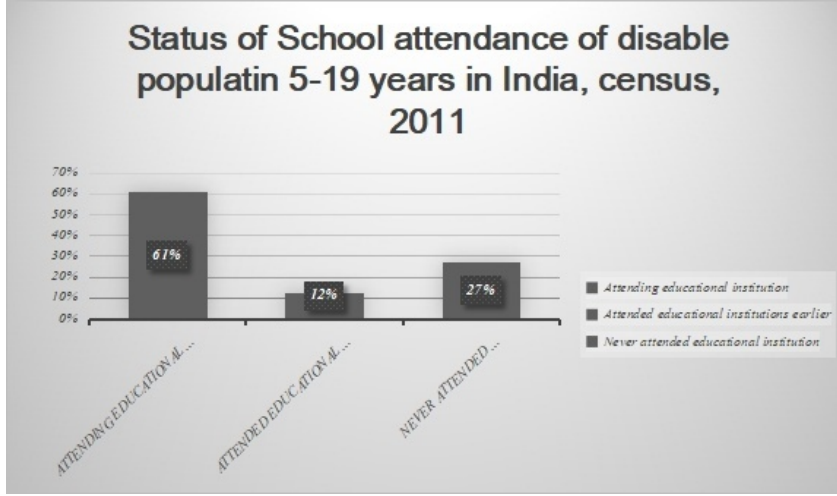
ઉંમર પ્રમાણે અક્ષમતા ધરાવતી જન સંખ્યા

આલેખ-2

ઉપરના ગ્રાફને આધારે વિવિધ ઉંમરના લોકો કેટલા પ્રમાણની અક્ષમતા ધરાવે છે તેના આંકડા દર્શાવે છે. 5 થી 9 વર્ષના બાળકોની અક્ષમતાનું પ્રમાણ 7% જોવા મળે છે. 10 થી 19 વર્ષના બાળકોનું પ્રમાણ 17% છે. જે વધારે છે તેનો અનુબંધ પ્રાથમિક અને માધ્યમિક શાળા શિક્ષણ સાથે જોડાયેલ છે. 16% પ્રમાણ 20 થી 29 વર્ષમાં જોવા મળે છે. જે ઉચ્ચ શિક્ષણનો તબક્કો છે. 30 થી 39 વર્ષની અક્ષમતાનું પ્રમાણ 13% જોવા મળે છે. 12% લોકો 40 થી 49 વર્ષની ઉંમરની અક્ષમતા સાથે જોડાયેલ છે. 50 થી 59 વર્ષની ઉંમરના લોકોનું પ્રમાણ 9% જોવા મળે છે. 10% લોકો 60 થી 69 વર્ષના અક્ષમતા સાથે જોડાયેલ છે. 7% લોકો 70 થી 79 વર્ષની ઉંમરના છે. 80 થી 89 વર્ષના લોકોનું પ્રમાણ 3% છે. જ્યારે 1% લોકો 90 વર્ષની ઉપરના અક્ષમતા સાથે જોડાયેલા છે. અક્ષમતાનો ઉંમર સાથેનો તબક્કો શિક્ષણ સમય સાથે જોડાયેલો છે. જે સમાવેશની જરૂરિયાત સૂચવે છે.

અક્ષમતા ધરાવતા બાળકોની શાળામાં હાજરીની પરિસ્થિતિ દર્શાવતાં આંકડા નીચે મુજબ છે.

અક્ષમતા આધારિત શાળામાં હાજરી ધરાવતા બાળકોની જનસંખ્યા



અક્ષમતા આધારિત શાળામાં હાજરી ધરાવતા બાળકોની જનસંખ્યા

આલેખ-3

5 થી 19 વર્ષના બાળકોની હાજરી અંગે ઉપરના ગ્રાફ પ્રમાણે 61% લોકો શાળામાં હાજર રહે છે. 12% લોકો શાળામાં વહેલો પ્રવેશ મેળવે છે. જે ચિંતાનો વિષય છે. અને 27 % અક્ષમતા ધરાવતા લોકોએ શાળા સુધી હજી પ્રવેશ જ મેળવ્યો નથી. તેથી સમાવેશન અંગે ગંભીરતાથી પગલાં લેવા પડે તેવી પરિસ્થિતિ ભારત દેશમાં છે.

ઉપરની વિગતોદર્શાવે છે આવનાર સમયમાં સમાવેશક શિક્ષણ અંગે સજાગતા કેળવવી પડશે. ભારતનું ભાવિ વર્ગખંડમાં ઘડાઈ રહ્યું છે અને શિક્ષક ભવિષ્યનો ઘડવૈયો છે ત્યારે આવનાર સમયમાં તૈયાર થનાર શિક્ષક એટલે પ્રશિક્ષણાર્થીની જવાબદારી સવિશેષ બની રહેશે. તેણે બાળકોની અક્ષમતા અંગે સજ્જ થવું પડશે અને સમાવેશી શિક્ષણ અંગે જાગૃતિ કેળવવી પડશે. એક જ વર્ગખંડમાં જ્યારે સક્ષમ અને અક્ષમ બંને પ્રકારના બાળકો શિક્ષણની પ્રક્રિયામાં સાથે જોડાયેલા હોય છે ત્યારે શિક્ષકની ભૂમિકા ખૂબ મહત્વની બની જાય છે. આ માટે પ્રશિક્ષણાર્થીએ શિક્ષકની તાલીમ લેતી વખતે સમાવેશક શિક્ષણનો અર્થ અને અક્ષમતાના પ્રકારો જાણવા જરૂરી છે.

સમાવેશક શિક્ષણ નો અર્થ:

- સમાવેશક શિક્ષણ એટલે એવું શિક્ષણ જેમાં સક્ષમ અને અક્ષમ બાળકો વચ્ચે સાયુજ્ય અને સંવાદિતતાનું સર્જન થાય.

- માનસિક શક્તિ, શારીરિક ક્ષમતા, સંવેગિક ક્ષમતા, પ્રત્યાયન કૌશલ્ય, વ્યક્તિત્વ વગેરેમાં વૈયક્તિક ભિન્નતા વાળા બાળકોને સામાન્ય બાળકોની સાથે રાખીને વર્ગ અધ્યાપન કાર્ય કરવામાં ત્યારે તેને સમાવેશન કર્યો એમ કહેવાય છે.
- જે શિક્ષણમાં આ તમામ બાળકો એકબીજાનું માન જાળવે, શારીરિક, માનસિક, વાર્તાનિક કે અન્ય કોઈપણ પ્રકારની ક્ષમતા કે અક્ષમતાને ધ્યાનમાં લીધા સિવાય પ્રત્યેક બાળકને તેની ઉંમર અને જરૂરિયાત મુજબ એક સાથે શિક્ષણ આપવામાં આવે તે સમાવેશક શિક્ષણ. ભવિષ્યના વર્ગખંડોમાં જ્યારે સક્ષમ અને અક્ષમ બંને પ્રકારના બાળકો શિક્ષણની પ્રક્રિયા સાથે જોડાયેલા હોય છે ત્યારે પ્રશિક્ષણાર્થીની ભૂમિકા ખૂબ મહત્વની બની જાય છે તેણે અક્ષમતાના પ્રકાર અંગે પણ જાગૃતિ કેળવી પડશે.

અક્ષમતાના પ્રકાર:

આવનાર સમયમાં વર્ગખંડમાં સમાવેશક શિક્ષણે સ્થાન લીધું હશે ત્યારે પ્રશિક્ષણાર્થીએ વર્ગખંડના વિદ્યાર્થીઓને જાણવા પડશે અને સમજવા પડશે. વર્ગખંડના વિદ્યાર્થીઓની અક્ષમતાઓથી પણ પરિચિત થવું પડશે અને સમજવા પડશે. અક્ષમતાના પ્રકારો વિશે પોતાનામાં જાગૃતિ લાવવી પડશે.

PwD Act 2016 પ્રમાણે 21 પ્રકારની અક્ષમતાઓ નોંધવામાં આવી છે. જેમકે અંધત્વ, ઓછી દ્રષ્ટી, રક્તપિત સાજા વ્યક્તિ, સાંભળવાની ક્ષતિ, લોકોમોટર ડિસેબિલિટી, વામનતા, બૌદ્ધિક અપંગતા, માનસિક બીમારી, ઓટિઝમ સ્પેક્ટ્રમ ડિસઓર્ડર, સેરેબ્રલ પાલ્સી, મસ્ક્યુલર ડિસ્ટ્રોફ, ક્રોનિક ન્યુરોલોજીકલ પરિસ્થિતિ, ડિસ્લેક્સિયા, (વિશિષ્ટ શીખવાની અક્ષમતા) મલ્ટીપલ સ્કેલોરોસીસ, વાણી અને ભાષાની અક્ષમતા, થેલેસેમિયા, હિમોફિલિયા, સિકલ સેલ, બહેરા-અંધત્વ સહિત બહુવિધ વિકલાંગતા, એસિડ એટેક, પાર્કિન્સન વગેરે અક્ષમતાઓ જણાવવામાં આવી છે.

વળી, Autism Awareness and Help ધ્વારા અક્ષમતાઓનું વિભાગીકરણ આ મુજબ પણ જોવા મળે છે.

સારણી-1
અપંગતાના પ્રકારો

List of Disabilities		
શારીરિક વિકલાંગતા	લોકોમોટોર અપંગતા	• રક્તપિત સાજા વ્યક્તિ • સેલિબ્રલપાલ્સી • વામાનવાદ • મસ્ક્યુલર ડિસ્ટ્રોફી • એસિડ એટેક
	દ્રશ્યક્ષતિ	• અંધત્વ • ઓછીદ્રષ્ટિ
	સાંભળવાની ક્ષતિ	• બહેરાશ • સાંભળવાની ઓછી ક્ષમતા
	વાણી અને ભાષાની અક્ષમતા	
બૌદ્ધિક અપંગતા	ચોક્કસ શીખવાની અક્ષમતા ઓટીઝમ સ્પેક્ટ્રમ ડિસઓર્ડર	
વિકલાંગતા થવાના કારણો	ક્રોનિક ન્યુરોલોજીકલ શરતો	• મલ્ટિપલ સ્કેલઓરોસીસ • પાર્કિન્સન
	બ્લડ ડિસઓર્ડર	• હિમોફિલિયા • થેલેસેમિયા • સિકલસેલ ડીસીઝ
માનસિક બીમારી		
બહુવિધ અક્ષમતા		

1983ના ભારતના સર્વેક્ષણ અનુસાર ભારતમાં લગભગ 12 મિલિયન લોકો એક અથવા બીજી ખોડખાંપણ ધરાવે છે. આમાંના કેટલાંક અંધત્વની, બહેરાશની, બોલચાલની ખોડખાંપણ ધરાવે છે. કેટલાંક હાડકાંની અને સ્નાયુની ખોડખાંપણ ધરાવે છે. શારીરિક અશક્ત બાળકોની સંખ્યા જોઈએ તો દિવસે દિવસે વધતી જાય છે. શારીરિક અશક્ત બાળકો જન્મ લે છે તેથી તેની સંખ્યામાં સતત વધારો થઈ રહ્યો છે. આ બાબત ભારત માટે ચિંતાનો વિષય છે માટે પ્રશિક્ષણાર્થીએ ઉપરની તમામ અક્ષમતા ઓ શું છે? તેના લક્ષણો કેવા પ્રકારના છે? તેનું

સમાવેશન કરવા કઈ બાબતો ધ્યાનમાં રાખવી? આ બધી જ બાબતો અંગે સજ્જતા કેળવવી પડશે.

પ્રશિક્ષણાર્થીની અક્ષમ બાળકો અંગેની સજ્જતા :

પ્રશિક્ષણાર્થીએ,

- બાળકોમાં રહેલા વૈવિધ્યને સૌ પ્રથમ ઓળખવું પડશે.
- વૈવિધ્યને આધારે બાળકોની શૈક્ષણિક જરૂરિયાતોને ઊંડાણપૂર્વક સમજવી પડશે.
- વર્ગખંડના તમામ વિદ્યાર્થીઓને કેવા પ્રકારની અધ્યયન સમસ્યાઓ છે? તે અંગે વિસ્તૃત અભ્યાસ કરવો પડશે.
- અક્ષમ બાળકો સાથે વાર્તાલાપ કરવા માટે કોઈ સાંકેતિક ભાષાનો ઉપયોગ કરવો અને આવશ્યક હોય તો તેનું પણ જ્ઞાન લેવું પડશે.
- બાળકની અક્ષમતાને ધ્યાનમાં રાખીને કેવો વ્યવહાર કરવો તે માટે નિષ્ણાતોની સલાહ લેવી જરૂરી બનશે.
- પ્રત્યેક બાળકને સામાજિક સ્વીકૃતિ મળે તે માટે તેમનામાં આત્મવિશ્વાસની વૃદ્ધિ કરવી પડશે.
- બાળકની શૈક્ષણિક સમસ્યાનો તાત્કાલિક ઉકેલ મળે તે માટે પ્રયત્ન કરવા પડશે.
- સામૂહિક પ્રવૃત્તિ દ્વારા સામાજિક આંતરક્રિયા કરવા માટેની પ્રત્યેક બાળકને તક પૂરી પાડવી પડશે.
- તેમનો સામાજિક વિકાસ યોગ્ય દિશામાં થાય તે અંગેના પ્રયત્ન પણ કરવા પડશે.

પ્રશિક્ષણાર્થીની વર્ગખંડની સજ્જતા:

સમાવેશક શિક્ષણમાં વર્ગખંડની ભૂમિકા ખૂબ મહત્વની છે કારણ કે વર્ગખંડમાં જ સ્વર્ગનું નિર્માણ થાય છે. આથી બાળકને ઘડતરની પ્રક્રિયામાં જોડવા માટે પ્રશિક્ષણાર્થીએ,

- બાળકોને જુદા જુદા વર્ગમાં વર્ગીકૃત કરવા પડશે.
- વર્ગખંડમાં અક્ષમ બાળકોને અનુરૂપ શૈક્ષણિક સાધનો અને શૈક્ષણિક ટેકનોલોજીનો ઉપયોગ કરતા શીખવું પડશે.
- અક્ષમ બાળકોને ધ્યાનમાં રાખી કયા પ્રકારની શૈક્ષણિક પદ્ધતિઓ અને પ્રવૃત્તિનો ઉપયોગ કરવો તે અંગેનું જ્ઞાન મેળવવું પડશે.

- સ્વાધ્યાય કાર્ય આપતી વખતે બાળકોની અક્ષમતા માટે કઈ બાબતો ધ્યાનમાં રાખવી તે અંગે જાણકારી પ્રાપ્ત કરવી પડશે.
- વર્ગનું પ્રત્યેક બાળક જાતે સ્વાધ્યાય કાર્ય કરી શકે તે અંગેની સંપૂર્ણ તૈયારી પણ તેણે કરવી પડશે.
- ઉપચારાત્મક કાર્ય કરવા માટે શાળા સમય પહેલા અને પછી વિશેષ સમય ફાળવવો પડશે.
- વર્ગખંડમાં સહયોગી બાળકને અક્ષમ બાળકને મદદરૂપ થવા માટે યોગ્ય માર્ગદર્શન આપવું પડશે.
- વર્ગખંડમાં અન્ય બાળકો વચ્ચે અક્ષમ બાળકોની સ્વીકૃતિ વધે તે પ્રકારના વાતાવરણનું સર્જન કરવું પડશે.
- નવા મુદ્દાની રજૂઆત કરતા પહેલા અગાઉના મુદ્દાનું પુનરાવર્તન કરવું પડશે.
- બાળક કઈ પરિસ્થિતિમાં વધુ આરામદાયક કાર્ય કરી શકે છે તે અંગે જાણકારી મેળવી વર્ગખંડમાં તેવા પ્રકારની પરિસ્થિતિનું નિર્માણ કરવું પડશે.

પ્રશિક્ષણાર્થીનું વાલી પ્રત્યેનું પરામર્શન :

બાળકના ઘડતરમાં શિક્ષક અને વાલી બંનેનો સહયોગ જરૂરી છે પ્રશિક્ષણાર્થીએ શિક્ષકની તાલીમ લેતી વખતે વાલી પરામર્શન વખતે કઈ બાબતો ધ્યાનમાં રાખવી તે અંગે પણ સજ્જતા કેળવવી પડશે. પ્રશિક્ષણાર્થીએ,

- બાળકને અક્ષમતા ક્યારથી છે? જન્મ પછી અક્ષમતાનો વિકાસ થયો હોય તો તેના કારણો કયા છે? તેનો યોગ્ય ઉછેર, ઈલાજ વગેરેની સંપૂર્ણ માહિતીથી પરિચિત થવું પડશે.
- બાળકની ભૂતકાળની શૈક્ષણિક પ્રગતિ અંગે પણ જાણકારી રાખવી પડશે.
- બાળકના માતા પિતાની સામાજિક અને આર્થિક પરિસ્થિતિ તેમજ તેમની શૈક્ષણિક લાયકાતો જાણવી પડશે.
- નિયમિત અંતરે બાળક અને વાલી બંનેનું પરાવર્તન કરવું પડશે.
- વાલીને અક્ષમ બાળકોના શિક્ષણ સંદર્ભમાં સરકારી નીતિથી પરિચિત કરવા પડશે.
- વાલી અને બાળક બંનેના અહમને હાનિ ના પહોંચે અને સંવેગિક રીતે મજબૂત બને તે માટેના પ્રયત્નો કરવા પડશે.

ઉપસંહાર:

ઉપર સૂચવેલી બાબતો પ્રત્યે પ્રશિક્ષણાર્થીની સજ્જતા અને જાગૃતિ ખૂબ મહત્વની છે. કારણ કે NCTE એ શિક્ષક પ્રશિક્ષણ કાર્યક્રમમાં સમાવેશક શિક્ષણને એક વિષય તરીકે શીખવા પર ભાર મૂક્યો છે અને તે અંગેની સ્પષ્ટતા તેના 2014ના રેગ્યુલેશનમાં કરવામાં આવી છે. નવી શિક્ષણ નીતિ 2020ની રૂપરેખા મુજબ સમાવેશક શિક્ષણ પણ વર્તમાન સમયમાં જરૂરી બન્યું છે ત્યારે શિક્ષકની તાલીમ લેતા પ્રશિક્ષણાર્થીની સજ્જતા મહત્વની બની છે. તો આવો શિક્ષણ જગત સાથે સંકળાયેલા આપણે સૌ સાથે મળીને સમાવેશક શિક્ષણમાં પ્રશિક્ષણાર્થીની સજ્જતા કેળવીએ અને વિશ્વના પ્રત્યેક બાળકને શિક્ષણના સહભાગી બનાવીએ કારણકે દિવ્યાંગ બાળકોને પણ ફૂલવા-ફાલવાનો અધિકાર છે, તેમને પણ અન્ય બાળકોની જેમ અધિકારો મળવા જોઈએ. તેમનામાં કેટલીક વિશિષ્ટ શક્તિઓ પડેલી હોય છે. તેમને જો યોગ્ય તકો પૂરી પાડવામાં આવે તો તે પણ સામાન્ય બાળકોની જેમ વિકાસ સાધી શકે છે. તેઓ પણ ભારતના નાગરિકો છે. અને નાગરિકો જેવા સમાન હક્કો ધરાવે છે. તો ચાલો, દિવ્યાંગને દયા નહિ પણ આત્મસન્માન આપીએ, તેમની સાથે સહૃદયતા પૂર્વક વ્યવહાર કરીએ, તેમના પ્રત્યે સદ્ભાવ રાખીએ, તેમને આત્મનિર્ભરની સાથે સૌ સાથે મળીને તેમને શિક્ષિત બનાવીએ.

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सारांश

शिक्षक शिक्षामें गुणवत्ता एक बहु आयामी अवधारणा है, जिसमें पाठ्यक्रम, मानवसंसाधन, प्रशासन, भौतिकसंसाधन और संपूर्ण शिक्षण वातावरण शामिल हैं। इस क्षेत्रमें गुणवत्तापूर्ण शोधकी बढ़ती आवश्यकता को देखते हुए, कई उभरते हुए क्षेत्रों पर विशेष ध्यान देने की आवश्यकता है। शिक्षक शिक्षाकी प्रभावशीलता नवाचार, व्यावसायिक विकास, सामुदायिक भागीदारी और नीतिगत क्रियान्वयन पर निर्भर करती है। जिसमें पाठ्यक्रम सुधार, डिजिटल एकीकरण, शिक्षक मूल्यांकन, आत्म-अनुशासन और संस्थागत उत्कृष्टता शामिल हैं। इसके अलावा, सिद्धांत और व्यवहार के बीचकी खाईको पाटने, संकट प्रबंधन कौशल विकसित करने और शिक्षामें टीम वर्ककी भूमिका कोभी रेखांकित किया गया है। शिक्षण और शोधमानकों को बनाए रखने के लिए आत्म मूल्यांकन और प्रत्यायन (Accreditation) की प्रक्रिया पर भी जोर दिया गया है। शिक्षक शिक्षकों को सशक्त बनाने, नवाचारोंको लागू करने, आत्म-निर्देशित अधिगम को बढ़ावा देने और शिक्षक तैयारीके द्रोत था विद्यालयों के बीच तालमेल स्थापित करने जैसे विषयों पर क्रियात्मक अनुसन्धान (Action Research) की आवश्यकता को रेखांकित करता है। इन पहलुओं पर ध्यान केंद्रित करके, शिक्षक शिक्षाको समकालीन चुनौतियोंके अनुरूप विकसित किया जा सकता है, जिस से गुणवत्तापूर्ण शिक्षण और अधिगम परिणाम सुनिश्चित किए जा सकें।

मूलशब्द- गुणवत्ता, शिक्षक शिक्षा, अनुसंधान, शोध, शिक्षक मूल्यांकन

परिचय

शिक्षक शिक्षा संस्थान (TEIs) भविष्यके शिक्षकों को तैयार करनेमें महत्वपूर्ण भूमिका निभाते हैं। शिक्षक शिक्षाकी गुणवत्ता सीधे विद्यालयी शिक्षण और अधिगम की प्रभावशीलता को प्रभावित करती है। हाल के वर्षोंमें, TEIs में गुणवत्ता संवर्धन पर शोध महत्वपूर्ण हो गया है ताकि शिक्षक प्रशिक्षण कार्यक्रम वैश्विक और राष्ट्रीय शैक्षिक मानकों को पूरा कर सकें। यह अध्याय TEIs की गुणवत्ता संवर्धनमें योगदान देनेवाले प्रमुख अनुसंधान क्षेत्रोंकी पहचान करता है। हर संस्थानमें एक शोध संस्कृति होनी चाहिए, और शोध क्षमताको मजबूत करने के लिए रणनीतियाँ विकसितकी जानी चाहिए। शोध और बौद्धिक सृजन एक नवाचारी व आलोचनात्मक दृष्टिकोण विकसित करने के लिए आवश्यक हैं। शोध भविष्यकी पीढ़ी की गुणवत्ता बढ़ा सकता है।

शोध और विकासमें बढ़ती हुई निवेश, सूचना प्रौद्योगिकी का उपयोग और बेहतर संचार से कौशल व दक्षतामें वृद्धि होगी यह वैश्विक उपलब्धियोंमें हमारे योगदान को भी बढ़ा सकता है। समय-समय पर हमने सिद्ध किया है कि भारतीयोंमें नवाचारकी अपार संभावनाएँ हैं। अंतरराष्ट्रीय शिक्षाके विकासके कारण अधिक जानकारी प्राप्त करने, सूचनाओं का आदान-प्रदान करने और सीमाओं के पार सहयोगको बढ़ावा देने की आवश्यकता बढ़

रही है। यह विशेष रूपसे विविधता, बच्चों और महिलाओं के मानवाधिकार जैसे सामान्य मुद्दोंको हल करनेमें मदद करेगा। इन क्षेत्रोंमें शोध सहयोगी कार्यप्रणाली को प्रोत्साहित करेगा और समस्याओं के समाधान के लिए सहजीवी संबंध बढ़ाएगा। शिक्षाकी इस क्षमताको पहचानते हुए, शिक्षक शिक्षा के माध्यमसे सशक्ति करण में महत्वपूर्ण भूमिका निभा सकता है, जिसे शिक्षा प्रणाली का अभिन्न अंग माना जाता है। इस दृष्टिकोण से, शिक्षक शिक्षा कार्यक्रमोंमें कुछ आवश्यक पहलकी जानी चाहिए। उभरते भारतीय समाजमें, ज्ञानसृजन, आदान-प्रदान, नेटवर्किंग और अधिकतम उपयोग राष्ट्रकी प्रगतिके लिए अत्यंत महत्वपूर्ण हो गए हैं। ज्ञानऔरसूचना साझा करना मूल्योंके निर्माण का एक प्रमुख संसाधन है। लेकिन साथ ही, यह भी एक गंभीर चिंताका विषय है किस भी स्तरों पर शिक्षाकी गुणवत्ता गिर रही है।

विश्वबैंक की रिपोर्ट के अनुसार, पूरी दुनिया उच्चशिक्षा संकटका सामना कर रही है, और यह संकट विकासशील देशोंमें सबसे गंभीर है। शिक्षण और शोध की गुणवत्तामें गिरावट आई है। मानकों को बनाए रखने और गुणवत्तामें सुधारके लिए, हमें प्रतिबद्धता, सभी कर्मियों की संपूर्ण भागीदारी, अनुकूल प्रबंधन, मुक्त बाजार वातावरण और संबंधित लोगोंके प्रशिक्षण की आवश्यकता है। इन सभी क्षेत्रोंमें उन्नयन और विकास केवल शोध के माध्यम से ही संभव है।

शिक्षा में गुणवत्ता

गुणवत्ता पूर्ण शिक्षा का मतलब ऐसी शिक्षा से हैं जो अपने निर्माण के उद्देश्यों को अच्छी तरह समझती। अगर आधुनिक युग की बात की जाएं तो किसी भी देश की शिक्षा को गुणवत्ता पूर्ण कहना गलत होगा। वर्तमान की शिक्षा अपने उद्देश्यों की प्राप्ति करने मेंअसफल रही हैं।गुणवत्तापूर्ण शिक्षा, शिक्षा में प्रायःउसी शिक्षा का समावेश होता है,जो शिक्षा शिक्षण.अधिगममें छात्रों की रुचि एवं क्षमताओं को समझे एवं समाज की आवश्यकताओं की पूर्ति करें और छात्रों कोजीवनदान देने योग्य बनाए।

गुणवत्ता पूर्ण शिक्षा एक ऐसी शिक्षा प्रणाली है जो सभी शिक्षार्थियों को ज्ञान कौशल मूल्य और दृष्टिकोण प्रदान करती है,जिस से वे व्यक्तिगत विकास,रोजगार,और समाजमें सक्रिय भागीदारी के लिए तैयार हो सकें।यह शिक्षा सुलभ,समावेशी,समानऔर प्रभावी होनी चाहिए ता कि आजीवन सीखने को प्रोत्साहित किया जा सके।

गुणवत्तापूर्ण शिक्षा के मुख्य तत्व:-

- संबंधित पाठ्यक्रम – छात्रों और समाज की आवश्यकताओं को पूरा करने वाली शिक्षा।
- प्रभावी शिक्षण पद्धतियाँ – प्रशिक्षित शिक्षक जो नवीन और आकर्षक तरीकों से पढ़ाते हैं
- सुरक्षित और समावेशी शिक्षण वातावरण – भेदभाव, हिंसा और सीखने में बाधा रहित स्कूल।
- पर्याप्त संसाधन – पुस्तकों, प्रौद्योगिकी, आधारभूत संरचना और शिक्षण सामग्री की उपलब्धता।
- मूल्यांकन और प्रतिक्रिया – छात्रों की प्रगति का नियमित आकलन और शिक्षण में सुधार।
- आजीवन सीखने के अवसर औपचारिक शिक्षा के बाद भी निरंतर सीखने को बढ़ावा देना।

संयुक्त राष्ट्र संघ की संस्थाएँ जैसे यूनेस्को और यूनिसेफ एसडीजी सतत विकास लक्ष्य पर जोर देती हैं जिसका उद्देश्य सभी के लिए समावेशी और समान गुणवत्तावाली शिक्षा सुनिश्चित करना और आजीवन सीखने के अवसरों को बढ़ावा देना है।

वर्तमान परिदृश्य

भारतीय शिक्षक शिक्षा संस्थान विकसित देशों के अपने समकक्षों से काफी पीछे हैं। विकसित देशों की विश्वविद्यालयों मुख्य रूप से शोध-आधारित होती हैं, जहाँ छात्र शोध के माध्यम से सर्वश्रेष्ठ रूप से सीखते हैं। हमें शिक्षा प्रणाली को अधिक नवाचारी और भविष्य उन्मुख बनाने की आवश्यकता है, ता कि यह समाज की बदलती आवश्यकताओं का उत्तर दे सके। औद्योगिक, परमाणु और वैज्ञानिक शोध की तुलना में गुणात्मक शैक्षिक शोध ने महत्वपूर्ण भूमिका नहीं निभाई है और इसे कोई विशेष प्राथमिकता भी नहीं मिली है। शैक्षिक शोध बहुत निम्न स्तर पर है। कई बार शोध केवल डिग्री प्राप्ति या पदोन्नति के लिए किया जाता है, जिससे इसकी वैधता और विश्वसनीयता प्रभावित होती है। व्यवस्थित और सतत प्रयासों की कमी है। हमारे देश में शिक्षा के लिए धन आवंटन विकसित देशों की तुलना में बहुत कम है। संख्या अधिक होने के बावजूद, उच्चशिक्षा हमारे राष्ट्रीय शोध और विकास खर्च का केवल 3% योगदान देती है, जब कि प्रमुख अर्थव्यवस्थाओं में यह 15-30% तक होता है।

एन.वेंकटैया ने अपनी पुस्तक "Educational Research in Indian Universities" में भारत में शोध की वर्तमान स्थिति का सटीक चित्रण किया है। उनके अनुसार, कुछ मुख्य बिंदु निम्नलिखित हैं—

विश्वविद्यालयों में शोध अपने-अपने विषयों की सुरक्षित सीमाओं में सीमित रहता है। बहुविषयक (Interdisciplinary) दृष्टिकोण बहुत कम अपनाया जाता है। शैक्षिक शोध अलग-थलग होते हैं और अक्सर गोपनीय रखे जाते हैं। शोध प्रस्ताव, योजनाएँ, प्रगति रिपोर्ट या निष्कर्षों पर विशेषज्ञों द्वारा आलोचनात्मक समीक्षा नहीं की जाती। शिक्षा क्षेत्र में शोध परियोजनाओं के लिए बहुत कम एजेंसियाँ वित्तीय सहायता प्रदान करती हैं। कई शोधार्थी इन एजेंसियों की जानकारी नहीं रखते, और जो जानते हैं, वे जटिल प्रक्रियाओं और औपचारिकताओं के कारण हतोत्साहित हो जाते हैं। शोध छात्रवृत्तियाँ भी गुणवत्ता सुनिश्चित करने में कारगर नहीं हो पातीं। शैक्षिक शोध बड़े संस्थानों द्वारा नहीं किए जाते, बल्कि ये बिखरे हुए और व्यक्तिगत स्तर पर सीमित रहते हैं। इनका कोई महत्वपूर्ण योगदान देखने को नहीं मिलता। किसी भी क्षेत्र में पूरी तरह से व्यवस्थित और समग्र (Gestalt Perspective) दृष्टिकोण अपना कर शोध करना एक अकेले शोधकर्ता के लिए कठिन होता है।

शिक्षक शिक्षा संस्थानों में गुणवत्ता संवर्धन

शिक्षक शिक्षा संस्थानों (TEIs) में गुणवत्ता संवर्द्धन एक महत्वपूर्ण पहलू है, जो शिक्षक प्रशिक्षण कार्यक्रमों की प्रभावशीलता सुनिश्चित करता है। यह शिक्षण-प्रशिक्षण प्रक्रिया, पाठ्यक्रम विकास, संकाय विकास, अनुसंधान, और संस्थागत प्रशासन में निरंतर सुधार को बढ़ावा देता है। यह अध्याय उन प्रमुख अनुसंधान क्षेत्रों का विश्लेषण करता है, जो TEIs की गुणवत्ता संवर्द्धन में योगदान करते हैं।

शिक्षक शिक्षा संस्थानों में गुणवत्ता संवर्धन हेतु शोध के क्षेत्र -

शिक्षक शिक्षा में गुणवत्ता एक बहु आयामी मुद्दा है, जिसे विभिन्न दृष्टिकोणों से देखा जा सकता है। इस क्षेत्र में शोध की संभावनाएँ निम्नलिखित प्रमुख बिंदुओं पर केंद्रित हो सकती हैं:

1. पाठ्यक्रम विकास और शिक्षणविधियों में नवाचार

1.1 कौशल-आधारित शिक्षक शिक्षा

शिक्षक शिक्षा में कौशल-आधारित दृष्टिकोण अपनाने की आवश्यकता पर शोध किया जा सकता है, शोध का लक्ष्य यह समझना है कि शिक्षक प्रशिक्षण कार्यक्रमों को कैसे कौशल-आधारित शिक्षा मॉडल के अनुरूप बनाया जा सकता जिसमें निम्नलिखित बिंदु शामिल हो सकते हैं:

- कार्यस्थल-केंद्रित प्रशिक्षण (Work-Integrated Learning) का प्रभाव।
- शिक्षकों में नेतृत्व और अनुसंधान कौशल का विकास।
- राष्ट्रीय शिक्षा नीति (NEP 2020) के अनुरूप शिक्षक शिक्षा कार्यक्रमों में बदलाव।
- व्यावसायिक कौशल (Professional Skills): शिक्षक बनने के लिए आवश्यक संचार, नेतृत्व, समस्या-समाधान और आलोचनात्मक चिंतन कौशलों को विकसित करने के तरीकों पर अध्ययन।
- प्रयोगात्मक अधिगम (Experiential Learning): वास्तविक कक्षा के अनुभवों के आधार पर शिक्षकों का प्रशिक्षण।
- व्यावसायिक विकास (Professional Development): शिक्षक शिक्षा कार्यक्रमों में सतत सीखने (Lifelong Learning) के महत्व पर शोध।

1.2 अनुभवात्मक और संरचनावादी अधिगम

- **संरचनावाद (Constructivism-Piaget, Vygotsky):** शिक्षक प्रशिक्षण में सक्रिय भागीदारी आधारित शिक्षण पद्धतियों का प्रभाव।
- **समस्या-आधारित शिक्षण (Problem-Based Learning - PBL):** शिक्षकों को समस्याओं के समाधान के लिए तैयार करने की विधियाँ।
- **जांच-आधारित शिक्षण (Inquiry-Based Learning):** शिक्षकों में अन्वेषणात्मक दृष्टिकोण को प्रोत्साहित करने की रणनीतियाँ।
- **सहयोगी अधिगम (Collaborative Learning) और जांच-आधारित शिक्षण (Inquiry-Based Learning) की भूमिका व्यावहारिक शिक्षण (Hands-on Learning) के लाभ।**

1.3 21वीं सदी के कौशलों का समावेश

शोध इस बात पर केंद्रित हो सकता है कि आलोचनात्मक चिंतन (**Critical Thinking**), सृजनात्मकता (**Creativity**), संचार (**Communication**), और सहयोग (**Collaboration**) जैसे कौशलों को शिक्षक प्रशिक्षण पाठ्यक्रम में कैसे शामिल किया जाए। कौशल-आधारित मूल्यांकन (**Skill-Based Assessment**) के लिए नए मॉडल विकसित करना।

2. प्रौद्योगिकी एकीकरण और डिजिटल साक्षरता

2.1 ई-लर्निंग और ब्लेंडेड लर्निंग

- ऑनलाइन और ऑफ लाइन शिक्षण (Blended Learning) का तुलनात्मक अध्ययन।
- लर्निंग मैनेजमेंट सिस्टम (LMS) जैसे Moodle, Google Classroom के प्रभाव का विश्लेषण।
- ऑनलाइन पाठ्यक्रमों (MOOCs, SWAYAM) की प्रभावशीलता पर शोध।

2.2 कृत्रिम बुद्धिमत्ता (AI) और वर्चुअल रियलिटी (VR) का उपयोग

- शिक्षक प्रशिक्षण में एआई-सक्षम टूल्स (AI-Enabled Tools) का उपयोग।
- वर्चुअल क्लासरूम और सिमुलेशन तकनीकों की प्रभावशीलता।
- डेटा एनालिटिक्स के माध्यम से शिक्षक प्रदर्शन मूल्यांकन।

2.3 डिजिटल साक्षरता और शिक्षकों का प्रशिक्षण

- शिक्षकों में डिजिटल साक्षरता कौशल को विकसित करने के तरीकों पर शोध।
- ऑनलाइन शिक्षण और मूल्यांकन के लिए शिक्षकों की तैयारी (Teacher Readiness for Online Teaching)।

3. मूल्यांकन और आकलन प्रणाली में सुधार

3.1 वैकल्पिक मूल्यांकन रणनीतियाँ

- पोर्टफोलियो मूल्यांकन (Portfolio-Based Assessment) की प्रभावशीलता।
- स्वयं और सहकर्मी मूल्यांकन (Self & Peer Assessment) का अध्ययन।
- आउटकम-आधारित मूल्यांकन (Outcome-Based Assessment - OBE) पर शोध।

3.2 शिक्षण प्रभावशीलता को मापने के लिए डेटा-संचालित दृष्टिकोण

- शिक्षकों के प्रदर्शन मूल्यांकन में डेटा विश्लेषण (Data Analytics in Teacher Evaluation)।
- रिफ्लेक्टिव प्रैक्टिस (Reflective Teaching Practices) और फीडबैक सिस्टम।

4. संकाय विकास और व्यावसायिक उन्नति

4.1 सतत व्यावसायिक विकास (Continuous Professional Development - CPD)

- कार्यशालाओं, प्रशिक्षण कार्यक्रमों और पुनश्चर्या पाठ्यक्रमों की प्रभावशीलता।
- ई-लर्निंग आधारित शिक्षक प्रशिक्षण पर शोध।

4.2 माइक्रो-टीचिंग और शिक्षक प्रशिक्षण मॉडल

- माइक्रो-टीचिंग (Micro-Teaching) तकनीकों की भूमिका।
- प्रशिक्षक-प्रशिक्षण मॉडल (Train-the-Trainer Approach) की प्रभावशीलता।

4.3 शिक्षकों के लिए परामर्श और सहकर्मी समर्थन

- मेंटोरशिप प्रोग्राम (Mentorship Models) का प्रभाव।
- शिक्षकों के लिए मानसिक स्वास्थ्य और कल्याण कार्यक्रम।

5. गुणवत्ता आश्वासन और प्रत्यायन (Accreditation)

5.1 गुणवत्ता आश्वासन रणनीतियाँ NAAC और NCTE मानकों के प्रभाव का अध्ययन

- शिक्षक शिक्षा संस्थानों में समग्र गुणवत्ता प्रबंधन (TQM - Total Quality Management) का उपयोग।

5.2 संस्थागत रैंकिंग और बेंचमार्किंग

- राष्ट्रीय और अंतरराष्ट्रीय स्तर पर शिक्षक शिक्षा कार्यक्रमों की तुलना।
- शिक्षक शिक्षा की गुणवत्ता में रैंकिंग प्रणालियों की भूमिका।

6. अनुसंधान और नवाचार (Research & Innovation in TEIs)

6.1 क्रियान्वयन शोध (Action Research)

- शिक्षकों द्वारा कक्षा की समस्याओं की पहचान और समाधान पर शोध।
- शिक्षण-अधिगम प्रक्रिया में एक्शन रिसर्च के प्रभाव।

6.2 बहु-अनुशासनात्मक (Interdisciplinary) शोध

- शिक्षा, मनोविज्ञान, समाजशास्त्र और प्रौद्योगिकी का समावेश।
- शिक्षानीति और इसके प्रभावों पर शोध।

7. समावेशी शिक्षा और विविधता

7.1 विशेष शिक्षा और समावेशी कक्षाएँ

- विशेष आवश्यकतावाले छात्रों के लिए शिक्षक प्रशिक्षण मॉडल।
- यूडीएल (Universal Design for Learning - UDL) के सिद्धांतों पर शोध।

7.2 बहुसांस्कृतिक और लिंग-संवेदनशील शिक्षा

- लिंग समानता और समावेशी पाठ्यक्रम विकास पर अध्ययन।
- विविध सामाजिक-सांस्कृतिक समूहों के लिए शिक्षक प्रशिक्षण कार्यक्रम।

8. स्कूल-टीईआई सहयोग और व्यावहारिक अधिगम

8.1 इंटरनशिप और प्रायोगिक शिक्षण मॉडल

- शिक्षा के क्षेत्र में स्कूल-टीईआई साझेदारी के लाभ।
- नवाचार आधारित इंटरनशिप मॉडल के प्रभाव पर शोध।

8.2 सामुदायिक सहभागिता और शिक्षक शिक्षा

- शिक्षक शिक्षा में सामुदायिक शिक्षण परियोजनाओं का प्रभाव।
- विद्यालय और शिक्षक शिक्षा संस्थानों के बीच सहयोग।

शिक्षक शिक्षा संस्थानों (TEIs) में गुणवत्ता संवर्धन की आधुनिक चुनौतियाँ-

शिक्षक शिक्षा की गुणवत्ता को बेहतर बनाने के लिए विभिन्न प्रयास किए जा रहे हैं, लेकिन इसके सामने कई आधुनिक चुनौतियाँ भी हैं। ये चुनौतियाँ न केवल संस्थागत प्रशासन से जुड़ी हैं, बल्कि शिक्षक प्रशिक्षण, तकनीकी संसाधनों, नीतिगत फैसलों और शोध-संस्कृति से भी संबंधित हैं। इन का समाधान किए बिना TEIs में संपूर्ण गुणवत्ता संवर्धन संभव नहीं है।

पाठ्यक्रम और शिक्षण पद्धति से जुड़ी चुनौतियाँ

- अप्रचलित पाठ्यक्रम (Outdated Curriculum)

कई TEIs में आज भी पारंपरिक और सैद्धांतिक पाठ्यक्रम का ही अधिक जोर है। शिक्षण प्रशिक्षण में व्यावहारिक और नवाचार-आधारित दृष्टिकोण की कमी। नई शिक्षा नीति (NEP 2020) के बावजूद कई संस्थानों में पुराने पाठ्यक्रम लागू हैं।

- **शिक्षण विधियों में नवीनता की कमी**

कई संस्थानों में अभी भी व्याख्यान-आधारित पारंपरिक शिक्षण पद्धति अपनाई जाती है। सक्रिय शिक्षण विधियाँ जैसे कि समस्या-आधारित अधिगम (PBL), प्रायोगिक शिक्षण और डिजिटल टूल्स का सीमित उपयोग।

शिक्षक और संकाय विकास से जुड़ी चुनौतियाँ

- **योग्य और प्रशिक्षित शिक्षकों की कमी**

कई संस्थानों में प्रशिक्षित और योग्य शिक्षक पर्याप्त संख्या में नहीं हैं। शिक्षकों को नई तकनीकों और आधुनिक शिक्षण विधियों का प्रशिक्षण देने की कमी।

- **सतत व्यावसायिक विकास (CPD) का अभाव**

शिक्षक प्रशिक्षण कार्यक्रमों की संख्या और गुणवत्ता दोनों में सुधार की आवश्यकता। शिक्षकों के लिए नियमित रूप से कार्यशालाएँ, ऑन लाइन पाठ्यक्रम और अनुसंधान गतिविधियों का सीमित अवसर।

डिजिटल और तकनीकी अवसंरचना से जुड़ी चुनौतियाँ

- **डिजिटल विभाजन (Digital Divide)**

ग्रामीण और शहरी क्षेत्रों के TEIs में डिजिटल संसाधनों की उपलब्धता में बड़ा अंतर। सभी प्रशिक्षु शिक्षकों और संकाय सदस्यों के पास उपयुक्त डिजिटल उपकरण और इंटरनेट सुविधाएँ उपलब्ध नहीं हैं।

- **ई-लर्निंग और ऑनलाइन शिक्षा की सीमाएँ**

ऑनलाइन शिक्षण के दौरान छात्रों की सक्रिय भागीदारी सुनिश्चित करना एक चुनौती। डिजिटल साक्षरता (Digital Literacy) की कमी के कारण कई शिक्षक और विद्यार्थी नई तकनीकों का प्रभावी ढंग से उपयोग नहीं कर पाते।

शोध और नवाचार से जुड़ी चुनौतियाँ

- **शोध-संस्कृति (Research Culture) का अभाव**

शिक्षक शिक्षा संस्थानों में अनुसंधान कार्यों पर अपेक्षित ध्यान नहीं दिया जाता। क्रियान्वयन शोध (Action Research) को बढ़ावा देने के लिए समुचित वित्तीय और प्रशासनिक समर्थन की कमी।

- **गुणवत्ता वाले शोध कार्यों की कमी**

कई संस्थानों में शोध पत्रों का प्रकाशन मात्र औपचारिकता बन कर रह गया है। गुणवत्ता वाले शोध को बढ़ावा देने के लिए उचित मार्गदर्शन और संसाधनों की आवश्यकता।

संस्थागत प्रशासन और नीतिगत चुनौतियाँ

- **मानकीकरण और प्रत्यायन (Accreditation) की कठिनाइयाँ**

बहुत से शिक्षक शिक्षा संस्थान अभी भी राष्ट्रीय प्रत्यायन निकायों (NAAC, NCTE) के मानकों को पूरा नहीं कर पा रहे हैं। गुणवत्ता नियंत्रण और निरीक्षण तंत्र को सशक्त बनाने की आवश्यकता।

- **सरकारी नीतियों और क्रियान्वयन में अंतर**

राष्ट्रीय शिक्षक शिक्षा ढांचे (NCFTE 2009) और नई शिक्षा नीति (NEP 2020) को प्रभावी ढंग से लागू करने में विभिन्न संस्थानों में असमानता। सरकारी सहायता प्राप्त और निजी संस्थानों के बीच संसाधनों की असमान उपलब्धता।

सामाजिक और आर्थिक चुनौतियाँ

- **शिक्षक प्रशिक्षण में प्रवेश की असमानता**

आर्थिक रूप से कम जोर वर्गों और हाशिए के समुदायों के लिए शिक्षक प्रशिक्षण कार्यक्रमों तक पहुँच सीमित। प्रवेश प्रक्रियाओं में अधिक समावेशिता और समान अवसर प्रदान करने की आवश्यकता।

- **शिक्षकों की सामाजिक स्थिति और करियर ग्रोथ**

भारत में शिक्षण पेशे को अब भी एक प्राथमिक करियर विकल्प के रूप में नहीं देखा जाता। नए शिक्षकों को स्थायी नौकरी और करियर ग्रोथ के पर्याप्त अवसर नहीं मिलते।

शिक्षक शिक्षा संस्थानों (TEIs) में गुणवत्ता संवर्धन की राह में कई आधुनिक चुनौतियाँ हैं। इन में पाठ्यक्रम सुधार, संकाय विकास, डिजिटल संसाधनों की उपलब्धता, शोध-संस्कृति को प्रोत्साहन, संस्थागत प्रशासन और सामाजिक-आर्थिक पहलुओं से जुड़े मुद्दे शामिल हैं। इन चुनौतियों के समाधान के लिए शिक्षण पद्धति में नवाचार, नीतियों का प्रभावी क्रियान्वयन, डिजिटल अव संरचना का विकास, और शिक्षकों के लिए सतत व्यावसायिक विकास के अवसरों को बढ़ावा देना आवश्यक है। यदि इन क्षेत्रों में समुचित सुधार किया जाए, तो शिक्षक शिक्षा संस्थान 21 वीं सदी की आवश्यकताओं के अनुरूप उत्कृष्ट शिक्षकों को तैयार कर सकते हैं।

शिक्षक शिक्षा संस्थानों (TEIs) में गुणवत्ता संवर्धन हेतु सुझाव -

- **पाठ्यक्रम और शिक्षण पद्धतियाँ**

पाठ्यक्रम और शिक्षण पद्धतियाँ समसामयिक और प्रासंगिक पाठ्यक्रम जो विद्यार्थियों की रुचि और भविष्य की आवश्यकताओं के अनुसार होना चाहिए तथा शिक्षकों को सीखने के आधुनिक तरीके जैसे कि सक्रिय शिक्षण (Active Learning), समस्या-आधारित शिक्षण (PBL), ब्लेंडेड लर्निंग और प्रोजेक्ट-आधारित शिक्षण का उपयोग करना चाहिए।

- **योग्य और प्रशिक्षित शिक्षक**

शिक्षकों को नई शिक्षण तकनीकों और ICT टूल्स का ज्ञान होना चाहिए एवं निरंतर प्रशिक्षण और कार्यशालाओं के माध्यम से शिक्षकों को अपनी क्षमता बढ़ाने का प्रयास करना चाहिए साथ ही शिक्षण को छात्र-केंद्रित करने पर ध्यान देना होगा।

- **मूल्यांकन और परीक्षा प्रणाली में सुधार**

मूल्यांकन और परीक्षा प्रणाली में सुधार करते हुए केवल रटने की प्रवृत्ति (Rote Learning) के बजाय समझ आधारित शिक्षण को बढ़ावा देना होगा। संस्थानों को सतत और व्यापक मूल्यांकन (CCE) का उपयोग करते हुए प्रायोगिक और व्यावहारिक ज्ञान को प्राथमिकता देना होगा।

• शैक्षिक संसाधनों और अधोसंरचना में सुधार

संस्थानों में स्मार्ट क्लासरूम, डिजिटल लाइब्रेरी, प्रयोगशालाएं और खेल सुविधाओं का विकास होना चाहिए एवं छात्र-अध्यापक अनुपात (Student-Teacher Ratio) संतुलित होना चाहिए। ग्रामीण और शहरी क्षेत्रों में समान शैक्षिक संसाधन उपलब्ध करने की कोशिश करनी होगी।

• समावेशी और समान शिक्षा

समावेशी और समान शिक्षा का अर्थ है कि प्रत्येक बच्चे को, चाहे वह किसी भी जाति, धर्म, लिंग, भाषा, सामाजिक-आर्थिक स्तर, या शारीरिक एवं मानसिक क्षमता का हो, गुणवत्ता पूर्ण शिक्षा का समान अवसर मिले। समावेशी शिक्षा का लक्ष्य सभी विद्यार्थियों को एक समान शैक्षिक वातावरण प्रदान करना है, जिसमें विशेष रूप से दिव्यांग बच्चे, वंचित समुदायों के छात्र, लैंगिक अल्प संख्यक, आर्थिक रूप से कमजोर वर्ग के बच्चे भी समान रूप से सीख सकें। समावेशी और समान शिक्षा से सभी बच्चों को बराबरी का अवसर मिलता है, जिससे वे आत्मनिर्भर और सशक्त नागरिक बन सकते हैं। राष्ट्रीय शिक्षा नीति (NEP 2020) के तहत सभी के लिए गुणवत्ता पूर्ण शिक्षा सुनिश्चित करना। इसके लिए नीतियों का प्रभावी क्रियान्वयन, शिक्षकों का प्रशिक्षण और संसाधनों का उचित वितरण आवश्यक है।

• शिक्षा में गुणवत्ता सुधारने के लिए सरकारी प्रयास

शिक्षा में गुणवत्ता सुधारने के लिए सरकारी प्रयास जैसे शिक्षा नीति (NEP 2020) के तहत नई पहल, सर्वशिक्षा अभियान (SSA), निष्ठा कार्यक्रम – शिक्षकों को प्रशिक्षित करने के लिए, DIKSHA पोर्टल – शिक्षकों और छात्रों के लिए डिजिटल संसाधन, SWAYAM, e-Pathshala, और PM eVidya जैसे ऑनलाइन प्लेटफॉर्म का अधिकतम उपयोग करना। स्कूलों में स्मार्ट क्लासरूम और ICT लैब की स्थापना, समग्र शिक्षा अभियान के तहत स्कूलों और शिक्षकों का उन्नयन। डिजिटल प्लेटफॉर्म (DIKSHA, SWAYAM, e-Pathshala) का उपयोग। स्कूली शिक्षा में नवाचार और व्यावसायिक शिक्षा को प्रोत्साहित करना। गुणवत्ता पूर्ण शिक्षा केवल ज्ञान का संचार नहीं, बल्कि व्यक्ति का समग्र विकास सुनिश्चित करने की प्रक्रिया है। शिक्षा में नवीनतम तकनीकों, समावेशी नीतियों और व्यवहारिक शिक्षण को अपनाकर गुणवत्ता में सुधार किया जा सकता है।

निष्कर्ष

शिक्षक शिक्षा की गुणवत्ता में सुधार एक बहु आयामी प्रक्रिया है, जिसमें पाठ्यक्रम सुधार, नवाचार, डिजिटल तकनीकों का समावेश, शिक्षक मूल्यांकन, आत्म-अनुशासन और संस्थागत उत्कृष्टता जैसी विभिन्न पहलुओं पर ध्यान देना आवश्यक है। गुणवत्ता पूर्ण शिक्षक शिक्षा केवल एक बेहतर पाठ्यक्रम तक सीमित नहीं है, बल्कि यह शिक्षकों के सतत व्यावसायिक विकास, प्रभावी प्रशासन, संसाधनों की उचित उपलब्धता और एक समावेशी अधिगम वातावरण पर भी निर्भर करती है। शिक्षक शिक्षा के क्षेत्र में आत्म मूल्यांकन, कार्यवाही शोध (Action Research), और निरंतर सुधार की आवश्यकता को नकारा नहीं जा सकता। शिक्षकों को सशक्त बनाने, नवाचारों को लागू करने, सामुदायिक भागीदारी बढ़ाने और सिद्धांत तथा व्यवहार के बीच की दूरी को कम करने की दिशा में ठोस प्रयास किए जाने चाहिए। इसके अलावा, शिक्षक प्रशिक्षण संस्थानों और विद्यालयों के बीच समन्वय बढ़ाने, संकट प्रबंधन कौशल विकसित करने, टीम वर्क को प्रोत्साहित करने और शिक्षण प्रक्रियाओं में लोकतांत्रिक मूल्यों को अपनाने की आवश्यकता है। शिक्षा नीति निर्माताओं, प्रशासकों और शिक्षकों को मिल कर एक प्रभावी रणनीति विकसित करनी होगी, जिस से शिक्षक शिक्षा को आधुनिक चुनौतियों के अनुरूप बनाया जा सके।

शिक्षक शिक्षा संस्थानों में गुणवत्ता संवर्धन के लिए नवाचार आधारित शिक्षण और प्रौद्योगिकी एकीकरण को प्राथमिकता दी जानी चाहिए। शिक्षण प्रभावशीलता को मापने के लिए वैकल्पिक मूल्यांकन विधियाँ अपनाई जानी चाहिए। फैकल्टी विकास कार्यक्रमों और परामर्श प्रणालियों को मजबूत किया जाना चाहिए। अनुसंधान और नवाचार को बढ़ावा देकर शिक्षक शिक्षा को अधिक प्रभावी बनाया जा सकता है। अतः, शिक्षक शिक्षा की गुणवत्ता बनाए रखने और सुधारने के लिए समग्र दृष्टिकोण आवश्यक है। नवाचार, अनुसंधान, आत्ममूल्यांकन, और सहभागिता आधारित शिक्षण रणनीतियों को अपनाकर ही शिक्षक शिक्षा को प्रभावी, व्यावहारिक और उन्नत बनाया जा सकता है।

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Vision 2030: The Future of Teacher Education in India

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Abstract

The landscape of education in India is evolving rapidly, driven by technological advancements and changing societal needs. In this context, the role of teachers is undergoing a significant transformation, necessitating a fundamental shift in teacher education practices. This article explores the emerging practices and paradigms reshaping teacher training in India, along with their potential implications and future directions. It identifies key challenges facing current teacher education programs, such as limited focus on practical skills and outdated curriculum, and proposes innovative solutions, including experiential learning, technology integration, and prioritizing social-emotional learning. Additionally, it discusses emerging paradigms reframing teacher education, moving towards learner-centered approaches, knowledge application, and collaborative learning. The article also examines the potential implications of evolving teacher education, including enhanced student learning outcomes and greater equity in education. Lastly, it outlines future directions for teacher education in India, emphasizing technology integration, competency-based models, and global collaboration. Overall, the article underscores the importance of embracing innovation and continuous improvement to empower educators and prepare them for the challenges of the 21st century classroom.

Keywords: Teacher Education, India, Emerging Practices, Paradigm Shift.

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INTRODUCTION

In the dynamic tapestry of India's education system, the role of the teacher is undergoing a significant transformation. No longer solely responsible for knowledge transmission, educators are poised to become architects of learning, crafting engaging experiences that equip students for the complexities of the 21st century. This necessitates a fundamental shift in teacher education, a field brimming with potential. This essay explores the emerging practices and paradigms reshaping teacher training in India, along with the potential implications and promising future directions of this crucial domain (Bransford, Donovan, & Pellegrino, 2000; NEP, 2020). By fostering a new generation of educators empowered with the necessary skills and vision, India

can unlock the immense potential of its education system, empowering students to thrive in a rapidly evolving world. The landscape of education is in a constant state of flux, driven by rapid advancements in technology, evolving societal needs, and a growing emphasis on preparing students for a dynamic and uncertain future. This continuous evolution necessitates a parallel transformation in the way we train and equip our teachers. Traditional models of teacher education, while valuable, may no longer be sufficient to meet the demands of the 21st century classroom.

THE NEED FOR CHANGE

The shortcomings of existing teacher education models are well-documented. Critics often point to a curriculum that is overly theoretical and disconnected from the realities of the classroom (Darling-Hammond, 2006). Additionally, traditional programs may not adequately prepare teachers to navigate the diverse needs of a globalized student population or leverage the power of technology to enhance learning (Friedman, 2006). This article argues that a paradigm shift is necessary to ensure that future generations of educators possess the skills and knowledge required to cultivate a thriving learning environment for all students. By delving into innovative approaches like residency programs, technology-integrated instruction, and a focus on social-emotional learning, we can foster a new generation of educators who are not only well-versed in subject matter but also adept at fostering critical thinking, collaboration, and lifelong learning skills in their students.

STRUCTURE OF THE ARTICLE

This article is divided into three sections. The first section, following this introduction, explores the key challenges facing current teacher education programmes. The second section delves into the emerging practices and paradigms that are shaping the future of the field. Finally, the article concludes with a discussion of the potential implications and future directions for this critical domain.

KEY CHALLENGES FACING TEACHER EDUCATION PROGRAMS IN INDIA

India's education system, while vast and ambitious, faces significant challenges in preparing its teachers for the demands of the 21st century classroom. Here, the researcher explores some of the key hurdles that current teacher education programs must overcome (Singh & Singh, 2018; Kumar, & Panwar, 2017; Yadav, 2016; Mittal, 2013):

1. Limited Focus on Practical Skills: Many programs prioritize theoretical knowledge over practical application. This leaves graduates unprepared for the

realities of classroom management, differentiated instruction, and catering to diverse learning styles.

2. Inadequate Infrastructure and Resources: Teacher education institutions often lack sufficient funding, leading to a shortage of qualified trainers, outdated learning materials, and inadequate technological resources. This hinders the quality of training and restricts exposure to innovative teaching methods.

3. Outdated Curriculum: The curriculum in some programs may not reflect the latest pedagogical approaches or integrate technology effectively. This disconnect can leave teachers ill-equipped to engage students and prepare them for a future heavily influenced by digital tools.

4. Limited Emphasis on Social-Emotional Learning: Teacher education programs often overlook the importance of social-emotional learning (SEL). This neglect leaves teachers unprepared to address the emotional well-being of their students, which is crucial for fostering a positive learning environment and promoting academic success.

5. Quality of Teacher Educators: There can be a shortage of highly qualified and experienced teacher educators, potentially impacting the quality of instruction and guidance provided to aspiring teachers.

6. Mismatch between Demand and Supply: The rapid expansion of the education sector has led to a mismatch between the demand for qualified teachers and the number of graduates from teacher education programs. This can result in underprepared or unqualified individuals entering the profession.

7. Lack of Continuous Professional Development: Many programs lack a structured system for ongoing professional development, leaving teachers with limited opportunities to adapt their skills and stay abreast of the latest educational advancements.

Addressing these challenges is crucial for ensuring that India produces a future generation of educators who can effectively equip students with the knowledge and skills needed to thrive in a globalized and ever-evolving world.

EMERGING PRACTICES RESHAPING TEACHER EDUCATION IN INDIA :

The teacher education landscape in India is undergoing a metamorphosis, driven by a growing need to equip educators for the demands of the 21st century classroom. Here, the researcher delves into some of the most promising emerging practices shaping the future of teacher training (CBSE, 2020; MHRD, 2018; UGC, 2018):

1. Embracing Experiential Learning: A shift from purely theoretical learning to a focus on experiential learning is reshaping teacher education. Programs are incorporating residencies, school-based internships, and practicum, placing aspiring

teachers alongside experienced mentors in real-world classrooms. This allows them to gain hands-on experience with classroom management, lesson planning, and navigating student diversity, fostering practical skills and a deeper understanding of the intricacies of teaching.

2. Integration of Technology as a Tool and Ally: The ubiquitous presence of technology in education is prompting teacher education programs to integrate technology tools and resources into their curriculum. This goes beyond basic computer literacy. Programs are focusing on equipping teachers with the skills to leverage technology for effective lesson planning, differentiated instruction, and fostering digital literacy in students. This could involve using online learning platforms, educational apps, interactive whiteboards, or even virtual reality (VR) for simulations.

3. Prioritizing Social-Emotional Learning (SEL): Recognizing the importance of nurturing the whole child, teacher education programs are integrating SEL principles. This equips future teachers with the tools to address the emotional well-being of their students. It involves learning strategies for creating positive classroom environments, promoting self-regulation and social skills development, and fostering emotional intelligence in themselves and their students. This can lead to improved student engagement, reduced behavioral issues, and a more supportive learning environment for all.

4. Collaborative Learning and Mentorship for Growth: A move towards collaborative learning environments and robust mentorship programs is fostering a more supportive and interactive learning experience for aspiring teachers. Peer-to-peer learning allows for knowledge and experience exchange, while guidance from experienced educators provides invaluable insights and support. Creating communities of learners where teachers can collaborate, share best practices, and learn from each other can foster a culture of continuous improvement and professional growth.

5. Continuous Professional Development (CPD) as a Lifelong Journey: The understanding that learning doesn't stop after graduation is leading to a growing emphasis on continuous professional development (CPD). Programs and initiatives are encouraging teachers to engage in ongoing learning opportunities, such as workshops, online courses, professional learning communities (PLCs), and conferences. This allows teachers to stay abreast of evolving educational practices, pedagogies, and advancements in technology, ensuring they remain effective educators throughout their careers.

6. Beyond the Practices: Embracing a Paradigm Shift: These emerging practices represent a significant shift in the paradigm of teacher education in India. The focus is moving from simply imparting knowledge to developing a well-rounded educator – one who possesses not only subject-matter expertise but also the pedagogical skills,

technological fluency, and social-emotional intelligence necessary to create a thriving learning environment for all students.

By embracing these practices and fostering a culture of continuous learning and adaptation, Indian teacher education programs can play a pivotal role in shaping a future generation of educators who are well-equipped to navigate the everevolving landscape of education and empower students to thrive in the 21st century.

EMERGING PARADIGMS: REFRAMING TEACHER EDUCATION IN INDIA : The future of teacher education in India is not just about incorporating new practices; it's about embracing a fundamental shift in how we view and prepare educators. Here, the researcher explores some of the emerging paradigms that are reshaping the landscape (Shulman, 1987; NCF, 2005; Fullan, 2007; Zhao, 2018):

1.From Teacher-Centered to Learner-Centered: Traditional models often place the teacher at the center of the learning experience. A new paradigm emphasizes a learner-centered approach, where aspiring teachers develop the skills to facilitate student-driven learning and cater to diverse learning styles. This involves fostering critical thinking, collaboration, and problem-solving skills in their students, preparing them for success in a world that demands adaptability and innovation.

2. Knowledge Acquisition to Knowledge Application: The focus is shifting from simply acquiring subject-matter knowledge to developing the ability to apply that knowledge effectively in the classroom. Teacher education programs are incorporating pedagogical frameworks that equip aspiring teachers with the skills to translate their expertise into engaging and interactive lesson plans that cater to the specific needs of their students. This ensures a deeper understanding and retention of knowledge for students.

3.Content Delivery to Curriculum Design: The traditional model of teachers solely delivering pre-designed curriculum is giving way to a paradigm that emphasizes curriculum design skills. Future educators will be empowered to create engaging and adaptable learning experiences that are relevant to the local context and cater to the evolving needs of the 21st century workplace. This could involve integrating project-based learning, incorporating technology tools, and fostering a culture of inquiry and exploration in the classroom.

4.Passive Consumers to Active Collaborators: Teacher education programs are moving away from a passive, lecturebased approach towards fostering active collaboration among aspiring teachers. This involves encouraging peer learning, group discussions, and problem-solving activities, promoting the development of critical thinking and communication skills. Additionally, collaboration with experienced educators through mentorship programs allows for knowledge sharing and the development of a supportive professional network.

5. Isolated Professionals to Connected Educators: The paradigm of the isolated teacher is being challenged by the rise of online communities, professional learning networks (PLNs), and collaborative platforms. These tools allow future educators to connect with colleagues across geographical boundaries, share best practices, and engage in continuous professional development throughout their careers. This fosters a sense of community and facilitates lifelong learning among educators.

6. The Teacher as a Change Agent: These emerging paradigms paint a picture of a future educator who is not just a dispenser of knowledge but a facilitator of learning, a curriculum designer, and a collaborator. They are change agents who can create dynamic and inclusive learning environments, fostering a love for learning in their students and empowering them to become critical thinkers and responsible citizens of the globalized world.

By embracing these paradigms, Indian teacher education programs can move beyond simply preparing teachers; they can equip them with the skills and vision to become architects of a future-proof education system that empowers all students to thrive.

POTENTIAL IMPLICATIONS OF EVOLVING TEACHER EDUCATION IN INDIA : The transformation of teacher education in India holds immense potential for reshaping the educational landscape of the country. Here, the researcher explores some of the key implications of these emerging trends (NIEPA, 2016; Ainscow, 2014; Mittal, 2013; Wachowczak, 2011; Desimone, 2009):

Positive Implications:

1.Enhanced Student Learning Outcomes: Equipping teachers with strong pedagogical skills, technological fluency, and a focus on social-emotional learning can lead to improved student learning outcomes. Students will benefit from engaging and interactive lessons, fostering critical thinking, creativity, and collaboration skills.

2.Reduced Teacher Attrition: By providing a more practical and well-rounded approach to teacher training, programs can address issues like job dissatisfaction and burnout, potentially leading to a decrease in teacher attrition rates. This translates to greater stability and continuity in the learning environment for students.

3. Improved Teacher Quality and Effectiveness: A focus on competency-based education and continuous professional development ensures a well-trained and adaptable teaching workforce. This translates to a higher standard of education delivery across the country, benefitting students from all backgrounds.

4. Greater Equity and Inclusion: By equipping teachers with the skills to cater to diverse learning styles and address the needs of all students, teacher education reform can promote greater equity and inclusion in the education system. This ensures that every child has the opportunity to reach their full potential, regardless of background or ability.

5. Empowered and Engaged Educators: Emerging paradigms that emphasize collaboration, lifelong learning, and active participation can empower future educators to become change agents within the education system. This fosters a more passionate and engaged teaching workforce, leading to continuous improvement and innovation in educational practices.

Challenges and Considerations:

1. Effective Implementation: The successful implementation of these reforms requires a multi-pronged approach. This includes addressing infrastructure limitations, providing adequate resources for teacher educators, and ensuring strong support systems for newly qualified teachers.

2. Collaboration and Partnerships: Effective change requires collaboration between various stakeholders, including government agencies, teacher training institutions, schools, and educational research organizations. This ensures that programs align with national education goals and address the specific needs of the education system.

3. Addressing Existing Teacher Workload: Implementing new pedagogies may require additional time and resources for teachers. Addressing existing workload concerns and providing adequate support is crucial for a smooth transition.

Overall, the evolving landscape of teacher education in India presents a promising opportunity to create a robust and future-oriented education system. By capitalizing on the potential of these emerging trends and addressing the associated challenges, India can empower its educators to nurture the next generation of global citizens.

FUTURE DIRECTIONS OF TEACHER EDUCATION IN INDIA: SHAPING A THRIVING EDUCATION SYSTEM : The winds of change are sweeping through teacher education in India, propelled by the need to prepare educators for the demands of the 21st century classroom. Here, the researcher explores some of the potential future directions that this vital field may take (CIET, 2021; NCERT, 2019; UNESCO, 2015):

1. Deepening the Focus on Technology Integration: Technology is no longer an optional tool; it's a fundamental aspect of modern education. Future directions could involve integrating courses on educational technology (EduTech) deeper into the curriculum, focusing not just on basic skills but also on the pedagogical applications of technology. This could encompass exploring the use of artificial intelligence (AI) for personalized learning, virtual reality (VR) for immersive simulations, and augmented reality (AR) for interactive learning experiences.

2. Embracing Competency-Based Models for Continuous Improvement: A shift towards competency-based teacher education models is gaining traction. These programs focus on developing specific skills and knowledge sets needed for effective teaching, assessed through performance-based measures. This future direction could involve ongoing assessments based on classroom observations, student learning

outcomes, and teacher reflections, creating a continuous improvement cycle for educators.

3.Nurturing a Culture of Inquiry and Research: Inculcating a research-oriented approach among educators can lead to a more evidence-based and data-driven education system. Future teacher education programs might encourage aspiring teachers to engage in action research, collaborating with peers and educational researchers to explore innovative practices and evaluate their effectiveness in the classroom.

4. Personalized Learning Pathways: Recognizing the diverse needs and interests of aspiring teachers, future programs may offer flexible and personalized learning pathways. This could involve online modules, blended learning approaches, and specialized electives allowing teachers to tailor their education to their specific career aspirations and teaching contexts.

5. Global Collaboration and Knowledge Exchange: The future of education is inherently global. International collaborations and knowledge exchange programs between Indian teacher education institutions and their global counterparts can foster a more dynamic and innovative learning environment for aspiring educators. This could involve joint curriculum development, student exchange programs, and online learning opportunities with educators from around the world.

6. Strengthening School-University Partnerships: Building stronger partnerships between teacher education institutions and schools can create a more seamless transition for aspiring teachers from theory to practice. Future directions may involve co-creating and implementing innovative teaching practices, collaborative research projects, and establishing professional development schools where teacher educators and experienced teachers work together to mentor future generations.

These potential directions point towards a future where teacher education in India is not just about imparting knowledge; it's about nurturing a critically reflective, technologically adept, and lifelong learner in every educator.

By embracing these future directions and fostering a culture of continuous innovation, Indian teacher education institutions can equip future educators with the skills and vision necessary to navigate the ever-evolving landscape of education and empower students to thrive in a dynamic and interconnected world.

CONCLUSION

The future of teacher education in India is ripe with opportunities for transformation and growth. The emerging practices and paradigms discussed in this essay offer a glimpse into a new era of teacher training that emphasizes practical skills, technological fluency, and social-emotional learning. By addressing the key challenges facing current teacher education programs and embracing innovative

approaches, India can pave the way for a more dynamic and inclusive education system.

The potential implications of evolving teacher education in India are far-reaching, from enhanced student learning outcomes to reduced teacher attrition rates and improved teacher quality and effectiveness. However, effective implementation and collaboration among various stakeholders will be crucial in realizing these positive outcomes.

Looking ahead, the future directions of teacher education in India hold promise for deeper integration of technology, competency-based models for continuous improvement, nurturing a culture of inquiry and research, personalized learning pathways, global collaboration, and strengthening school-university partnerships. By embracing these future directions and fostering a culture of continuous innovation, Indian teacher education institutions can equip future educators with the skills and vision necessary to navigate the ever-evolving landscape of education and empower students to thrive in a dynamic and interconnected world.

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Preparing Teachers beyond Content Delivery

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Abstract:

The preparation of teachers is a multifaceted process that goes beyond content delivery, encompassing pedagogical strategies, emotional intelligence, cultural awareness, and classroom management. Effective teacher preparation must cultivate not only subject knowledge but also the ability to foster critical thinking, create inclusive learning environments, and engage with diverse student needs. With the evolving landscape of education, teachers are increasingly tasked with addressing the socio-emotional development of students, integrating technology, and adapting to various learning styles (Darling-Hammond, 2006; McLeskey & Waldron, 2011). This shift demands a holistic approach to teacher preparation that includes ongoing professional development, collaboration, and reflective practice (Fullan, 2013). Teacher education programs must prioritize the development of skills such as communication, empathy, and adaptability, preparing educators to navigate challenges both inside and outside the classroom (Villegas & Lucas, 2002). Additionally, programs must focus on equity, ensuring that all teachers are equipped to create spaces where every student can succeed (Blazar & Kraft, 2017). As education systems continue to diversify and evolve, it is imperative that teachers are prepared to inspire, motivate, and support their students in ways that transcend traditional content delivery.

Keywords : *Teacher preparation, content delivery, pedagogical strategies, emotional intelligence, inclusive learning, professional development.*

We now accept the fact that learning is a lifelong process of keeping abreast of change. And the most pressing task is to teach people how to learn.” – Peter Drucker.

Introduction

Teaching is an art and a science that requires more than just the ability to convey information. While content delivery is undeniably important, effective teaching demands a wide range of skills that go far beyond the mere transfer of knowledge. Teachers are not just instructors; they are facilitators of learning, mentors, counselors, and leaders within the classroom. To prepare educators for these multifaceted roles, it

is crucial to equip them with the tools, strategies, and mindsets needed to navigate a dynamic and diverse educational landscape.

“Children must be taught how to think, not what to think.” There are several such quotes when we talk about education and we frequently use them in our dialogues, presentations and conversations, but have we actually pondered over them and realized how effective we as teachers are in the classroom?

Broadly defined Content delivery in education refers to the process of presenting, distributing, and transmitting educational materials and information to students. Let’s understand how we can prepare teachers of today and tomorrow to go beyond content delivery, emphasizing the holistic development of skills, pedagogy, and competencies that foster student engagement, critical thinking, social-emotional growth, and a deeper connection between educators and learners.

Why Teaching Is More Than a Profession

The role of a teacher goes far beyond delivering lessons from a textbook in today’s time. It’s about connecting and integrating curriculum with real world situations to instill wisdom, values, and life skills that students will carry forever. The impact of teaching is immeasurable. Unlike many other professions, a teacher’s influence extends far beyond the classroom walls. Teachers shape lives in ways they may never fully realize. Teachers must understand what a pupil understands and in the way he understands it. To understand better, we should learn to keep questioning. Like Sir Rudyard Kipling, we must keep six honest serving men: **What, Why, When, How, Where and Who.**

A passionate teacher is

Someone truly enamored of a field of knowledge, or deeply stirred by issues and ideas that challenge our world, or drawn to the crises and creativity of the young people who come into class each day-or all of these. To be a passionate teacher is to stop being isolated within a classroom, to refuse to submit to a culture of apathy or cynicism, to look beyond getting through the day (Fried, 1998, P.53).

Robert Fried defines passionate teaching in his book [*The Passionate Teacher: A Practical Guide*](#) (2001) as “someone in love with a field of knowledge, deeply stirred by issues and ideas that challenge our world, drawn to the dilemmas and potentials of the young people who come into class each day — or captivated by all of these.”

Effective content delivery starts with understanding your course goals, the needs of your students, and your own teaching style.

Start with a Purpose

Consider:

- **Who your students are and their needs:** One of the most important pedagogical approaches is differentiated instruction, where teachers tailor lessons to accommodate the varying needs, skills, and learning styles of their students. In a classroom, learners are not a homogenous group; they come with diverse backgrounds, abilities, and interests. To engage all students, teachers must adjust content, processes, and products.
- **What you want students to learn:** Every student has a story, and a teacher's ability to recognize and understand those stories can help them unlock a student's potential. The empathy and compassion that a teacher brings to the classroom can help students develop a sense of belonging, confidence, and resilience. This emotional investment goes beyond merely grading assignments—it's about being present for your students, emotionally and mentally, helping them navigate not only academic challenges but personal struggles as well.
- **How you'll measure their learning:** Shaping minds is a huge responsibility, and it really underscores the power teachers have in influencing the future. Beyond just imparting knowledge, a teacher's role in shaping minds involves guiding students through a process of self-discovery, critical thinking, and understanding of their place in the world. Teachers can scaffold learning through hints, prompts, modeling, and providing appropriate resources. As students become more skilled, the level of support decreases, allowing them to take ownership of their learning.

Teaching isn't just about imparting facts and information; it's about inspiring, guiding, and nurturing the next generation of thinkers, creators, and leaders. Besides delivering content in classrooms teaching transcends being a profession that reaches into the heart of society, and influences not only individuals but entire communities. **NEP 2020** envisions holistic education for learners. Recently, a new form of teaching, learning, and assessment have been explored, in order to guide teachers and policymakers in productive innovation, and proposed, under the title —**Innovating Pedagogy** and involves:

Pedagogical Competency

Understanding how students learn is central to effective teaching. Teachers must be equipped with a range of skills to meet the diverse needs of their students and foster an environment conducive to learning. Teachers must work on:

- **Differentiated Instruction:** Students come with varying learning styles, abilities, and interests. Differentiated instruction means tailoring lessons to

meet the diverse needs of students. By adapting lessons, materials, and assessments, educators can ensure that each student is provided with the appropriate level of challenge and support to succeed. This personalized approach helps to engage all students, regardless of their individual strengths or challenges.

- **Active Learning Strategies:** Engaging students in the learning process is essential for deeper understanding and retention. Active learning strategies, such as discussions, problem-solving tasks, collaborative projects, and experiential learning opportunities, allow students to take an active role in their education. These strategies not only foster critical thinking but also promote student motivation and engagement.
- **Assessment Literacy:** Teachers must be proficient in designing and utilizing both formative and summative assessments to track and measure student progress. Understanding how to analyze assessment data and adjust teaching methods accordingly is crucial for improving student outcomes and guiding instructional decisions.

Tailoring instruction:

Adjusting the content, process, or product based on students' readiness levels, interests, or learning profiles. Creating a learning path or set of activities based on a student's preferences or learning pace. Changing the way students are grouped for activities, based on their needs, skills, or interests. Sometimes students may work in pairs, groups, or independently, depending on the task. Incorporating different types of instructional materials such as videos, hands-on activities, technology, or alternative texts to support different learning preferences.

Classroom Management & Student Engagement

Creating a positive and structured learning environment is essential for fostering student success. Effective classroom management not only supports a productive atmosphere but also enhances student engagement. Key skills in this area include:

- **Behavioral Management:** Proactive strategies are crucial in minimizing disruptions and maintaining a focused classroom. Effective teachers implement clear expectations and consistent routines, as well as positive reinforcement to encourage desirable behavior. Addressing behavioral issues early, and in a fair and respectful manner, helps to create an environment where learning can thrive without interruptions.
- **Culturally Responsive Teaching:** Valuing and incorporating students' diverse backgrounds into lessons makes learning more relevant and inclusive. Culturally responsive teaching acknowledges students' cultural identities and integrates their experiences into the curriculum. This approach fosters a sense of belonging and ensures that all students see themselves reflected in the

learning process, ultimately promoting greater engagement and academic success.

Building Trust and Rapport:

Establishing positive relationships with students is fundamental to creating a classroom environment conducive to learning. Teachers need to understand how to build trust with students through consistent communication, active listening, and demonstrating genuine care and concern for their students' well-being. This requires a deep commitment to understanding the individual needs and backgrounds of students, ensuring that each student feels respected and valued.

Teachers should also be trained to recognize the signs of emotional distress in students and provide appropriate support, whether through listening, offering encouragement, or connecting students with counseling services. By building strong, trusting relationships, teachers can help students feel more comfortable taking risks, asking questions, and engaging with the material.

Encouraging Curiosity:

Teachers help their students discover not only academic knowledge but also life skills that will guide them long after they leave school. Teachers being aware of **STEAM** (Science, Technology, Engineering, Art and Mathematics) skills is essential, as they play a pivotal role in shaping students' understanding and interest in these areas. In teaching, you don't just give students the ability to solve math problems or write essays; you equip them with the tools to solve real-world challenges, make informed decisions, and contribute to society. Teachers can cultivate a sense of curiosity and a love for learning in their students. When students are curious, they take ownership of their learning and are motivated to explore the world beyond what is taught in textbooks. A teacher's job is to spark that curiosity, show how exciting learning can be, and make students realize how much they can discover on their own.

Instilling a Sense of Purpose:

Teachers have the ability to help students identify their interests, passions, and goals. By helping them see how what they're learning connects to the real world, a teacher can guide them toward finding a sense of purpose in their education and in life. When students feel that their learning is meaningful, they are more likely to stay engaged and motivated.

Promoting Self-Reflection:

One powerful way to shape minds is by encouraging students to reflect on their thoughts, actions, and beliefs. Activities like journaling, group discussions, or simply posing reflective questions can help students examine their own thinking. This fosters self-awareness and critical thinking, which are vital for personal growth and for understanding the broader world.

4. Fostering Open-Mindedness and Tolerance:

Teachers can create an environment where students feel comfortable sharing ideas, even if those ideas differ from the mainstream or the teacher's own views. By encouraging open dialogue, teachers help students develop empathy, learn to respect differing opinions, and engage with the world in a thoughtful, nonjudgmental way.

5. Teaching Accountability and Ownership:

Shaping minds also means teaching responsibility, not just for academic work, but also for behavior and actions. Teachers can encourage students to take ownership of their learning, decisions, and actions. This can include setting goals, following through with commitments, and learning from mistakes. The ability to be accountable for one's choices is a critical life skill.

6. Supporting Emotional and Mental Growth:

Teachers who are attuned to their students' emotional and mental well-being can have a profound effect on their development. Being a source of support, offering encouragement, and providing a safe space for students to express themselves fosters confidence and resilience. This emotional grounding is key to shaping a student's mindset. Teachers must possess strong emotional intelligence to navigate the complexities of the classroom. This includes:

- **Self-Awareness & Self-Regulation:** Teachers need to be aware of their own emotions and how these emotions impact their behavior and interactions. Self-regulation allows teachers to respond calmly and effectively, even in stressful situations. By managing their emotions, teachers can maintain a balanced approach to challenges, providing a stable presence for their students.
- **Empathy & Communication:** Understanding students' perspectives and being sensitive to their emotions is key to fostering a supportive classroom culture. Empathy helps teachers build meaningful relationships with students, creating an environment where students feel heard, valued, and understood. Effective communication is essential for conveying expectations, offering support, and building trust with students.
- **Conflict Resolution:** In any classroom, misunderstandings and disputes are inevitable. Teachers must be equipped with the skills to address conflicts constructively, facilitating open dialogue and helping students work through disagreements in a respectful manner.

7. Challenging Assumptions and Biases:

Teachers have the opportunity to challenge students' assumptions, stereotypes, and biases. By creating an inclusive classroom environment and discussing issues like social justice, equity, and ethics, teachers help shape students into critical thinkers who question the status quo and think deeply about fairness and morality.

8. Encouraging Ethical Decision-Making:

Teaching students how to make ethical decisions—whether it's about their academic work, relationships, or future careers—plays a major role in shaping their moral compass. This is about instilling values like integrity, respect for others, and the understanding that their actions have consequences.

9. Must be aware of the digital environment:

Teachers having ICT skills is not just about being able to use a computer or a smartphone—it's about using technology as a tool to enrich learning experiences, foster collaboration, and prepare students for the future. With the right ICT skills, teachers can adapt to an ever-changing educational landscape, ensuring that they meet the needs of their students and stay at the forefront of innovative teaching methods. As technology continues to shape the educational landscape, teachers must embrace innovative tools and methods to enhance learning experiences. Key areas of focus include:

- **Blended Learning Models:** Blended learning is an instructional approach that combines traditional face-to-face teaching with digital tools and online learning opportunities. This model provides students with the flexibility to learn at their own pace, using both in-person and digital resources.
- **Educational Technology Tools:** With the advent of digital platforms, teachers now have access to a wide array of tools that can enhance the learning process. Learning Management Systems (LMS) such as Google Classroom, Moodle, and Canvas enable teachers to organize content, track student progress, and foster collaboration. Interactive simulations and virtual classrooms further engage students by providing hands-on, experiential learning opportunities that would be difficult to replicate in a traditional setting.
- **Digital Citizenship:** As students engage with digital tools and platforms, it's crucial to teach them the responsible and ethical use of technology. Digital citizenship includes understanding the rights and responsibilities that come with being online, such as respecting others' privacy, recognizing the importance of online safety, and practicing good digital etiquette. Educators must guide students in navigating the digital world, emphasizing critical thinking, responsible decision-making, and the potential consequences of their online actions.

10. Shaping the Future of Society:

Ultimately, the minds teachers shape will go on to influence society at large. Teachers have the power to nurture compassionate, informed, and responsible citizens who are prepared to make thoughtful, positive contributions to the world. Whether it's through teaching social responsibility, environmental stewardship, or simply kindness and respect, teachers play a pivotal role in molding the future.

Teaching is so much more than just passing on knowledge—it's about shaping the minds and hearts of future generations. The responsibility is enormous, but the impact is lasting. What do you think about the idea of teachers as mind-shapers? Does it resonate with how you view the role of educators?

Lastly and most important a teacher is a Lifelong Learner:

Lifelong learning may be broadly defined as learning that is pursued throughout life: learning that is flexible, diverse and available at different times and in different places.

This definition is based on **Delors' (1996) four 'pillars' of education for the future.**

- **Learning to know** – mastering learning tools rather than acquisition of structured knowledge.
- **Learning to do** – equipping people for the types of work needed now and, in the future, including innovation and adaptation of learning to future work environments.
- **Learning to live together and with others** – peacefully resolving conflict, discovering other people and their cultures, fostering community capability, individual competence and capacity, economic resilience, and social inclusion.
- **Learning to be** – education contributing to a person's complete development: mind and body, intelligence, sensitivity, aesthetic appreciation and spirituality.

Institutions play a crucial role in fostering this growth by providing support for ongoing professional development. Key areas of support include:

- **Reflective Practice:** Encouraging teachers to engage in reflective practice is essential for their growth. Reflective practice involves regularly analyzing and evaluating one's teaching methods, classroom interactions, and student outcomes. This self-assessment allows educators to identify areas for improvement, test new strategies, and ultimately create more engaging and effective learning experiences for their students.
- **Mentorship & Collaboration:** A strong mentorship and collaborative culture among educators is vital for professional growth. Teachers can benefit from the guidance of more experienced colleagues, while also sharing knowledge and insights with others. Collaboration, whether through team teaching, professional learning communities, or peer observations, encourages the exchange of ideas, innovative solutions to problems, and the opportunity to learn from others' experiences.
- **Ongoing Training & Certifications:** Institutions should provide teachers with access to ongoing training opportunities that help them stay current with the latest pedagogical trends, technologies, and subject knowledge.

Workshops, advanced degrees, and specialized certifications allow teachers to deepen their expertise and stay engaged with the evolving landscape of education. By offering these opportunities, institutions demonstrate a commitment to the professional growth of their educators, ensuring that teachers remain equipped with the skills and knowledge necessary to meet the changing needs of their students.

Conclusion:

Preparing teachers beyond content delivery requires a comprehensive approach that goes beyond the traditional focus on subject expertise. Teachers must be equipped with the skills to manage classrooms, build relationships, understand and embrace cultural diversity, and foster critical thinking. They must also be prepared to collaborate with colleagues, engage with the community, and prioritize their own well-being.

By expanding teacher preparation to address these areas, we can ensure that teachers are not only experts in their fields but also skilled in meeting the diverse needs of their students. In doing so, we will create educators who are not only effective content deliverers but also empathetic mentors, advocates for social justice, and lifelong learners. The future of education depends on teachers who are prepared to go beyond the classroom and shape the world in meaningful ways.

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શિક્ષક પ્રશિક્ષણમાં આર્ટિફિશિયલ ન્યુરલ નેટવર્ક (ANN) ની ભૂમિકા

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સારાંશ

કેળવણીના ધ્યેયોની વાત કરવામાં આવે છે ત્યારે બુનિયાદી તાલીમના ભાગરૂપે ગાંધીજી હૈયું, મસ્તક અને હાથની કેળવણી દ્વારા ગાગરમાં સાગર જેવી વાત કરે છે. આધુનિક શૈક્ષણિક મનોવિજ્ઞાન પણ આ જ વાત બોધાત્મક, મનોશારીરિક અને ભાવાત્મક વિકાસના રૂપમાં પુનરોત્થારિત કરે છે. બોધાત્મક વિકાસ એ આ ત્રણેય પૈકી વર્તમાન શિક્ષણ વ્યવસ્થાનું કેન્દ્રબિંદુ બની ગયેલ છે. આપણે જ્યારે બોધાત્મક વિકાસની વાત કરીએ છીએ ત્યારે આપણે મગજ સાથે સંકળાયેલ વિકાસની વાત કરતાં હોઈએ છીએ. તરેહો, ઓળખ, સંકેતીકરણ, તર્ક, પૃથક્કરણ, વિશ્લેષણ, મૂલ્યાંકન, સર્જન, સમસ્યા ઉકેલ વગેરે જેવી પ્રક્રિયાઓ તેની સાથે સંકળાયેલી છે. મગજનો વિકાસ તેના પાયાના એકમ એટલે કે ન્યુરોન (ચેતકોષ) સાથે સંબંધ ધરાવે છે. આ દરેક ન્યુરોન એકબીજા સાથે ચેતોપાગમ (synapses) દ્વારા જોડાઈને એક સંકુલ નેટવર્ક તૈયાર કરે છે. આર્ટિફિશિયલ ન્યુરલ નેટવર્ક (ANN) એ આ ન્યુરોન્સની કાર્યપદ્ધતિ સાથે સંબંધ ધરાવે છે. ANN એ કુદરતી કે જૈવિક ન્યુરલ નેટવર્ક કરતાં જુદું પડે છે. કુદરતી રીતે તૈયાર થયેલ ન્યુરોન્સના નેટવર્કમાં ન્યુરોન એકબીજા સાથે જોડાઈને રાસાયણિક રીતે વિદ્યુતઆવેગ ઉત્પન્ન કરે છે અને સિગ્નલનું પ્રસારણ કરે છે. ANN એ મગજ દ્વારા પ્રેરિત એવું ગાણિતિક મોડેલ છે. તે કુદરતી એવા જૈવિક મોડેલ પરથી પ્રેરિત કૃત્રિમ મોડેલ છે. Artificial Neural Network એ Biological Neural Network પરથી ઉતરી આવેલ શબ્દ છે. તે ઈનપુટ (input), ગર્ભિત (hidden) અને આઉટપુટ (output) જેવા ત્રણ સ્તરો થકી કાર્ય કરે છે. Kourosh Borhani & Wong (2023) તેઓના અભ્યાસમાં વિદ્યાર્થીઓની અધ્યયન નિષ્પત્તિ અને અધ્યયન પ્રવૃત્તિઓમાં ANN ની ભૂમિકા અંગેનો અભ્યાસ કરેલ હતો. જેમાં એક ઘટક તરીકે ઊંઘની ગુણવત્તા અને તણાવ વચ્ચેનું જોડાણ તેઓ સ્થાપિત કરી શક્યા હતા. ઈનપુટ સ્તર દ્વારા પ્રાપ્ત ઈનપુટ, ગર્ભિત સ્તરમાં થયેલ પ્રક્રિયાના આધારે આઉટપુટનું નિર્ધારણ થાય છે, જે હવે પછીના ન્યુરોન માટે ઈનપુટનું કામ કરે છે. આઉટપુટ દ્વારા તૈયાર થયેલ આવેગની તીવ્રતા અને ભારાંક એ અધ્યયનની અસરકારકતા નક્કી કરે છે. અસરકારક અધ્યયન પ્રાપ્ત કરવા માટે મગજને વિવિધ ઈનપુટ આપીને તે દરેકની અસરકારકતાનો અભ્યાસ કરીને ઇચ્છિત ઈનપુટની ફોર્મ્યુલા તૈયાર કરી શકાય છે. એવા કેટલાક ઈનપુટનું જૂથ તૈયાર કરી શકાય કે જેના થકી ઇચ્છિત અધ્યયન નિષ્પત્તિ પ્રાપ્ત કરવાની સંભાવનાઓ વધી જાય છે. અરોરા (2013) ના મતે અત્યાધુનિક ટેકનોલોજીના કારણે વિદ્યાર્થીઓના વર્તન અને અધ્યયનને સમજવા માટે data mining અને analytics નો ઉપયોગ સંભવ બન્યો છે. જેનાથી તાલીમને વધુ વૈજ્ઞાનિક બનાવવાની સંભાવનાઓ વધી જાય છે. તાલીમ એ શિક્ષક પ્રશિક્ષણનું હાર્દ છે. તાલીમ દરમિયાન મગજના ન્યુરોન્સ વચ્ચે નવા જોડાણો તૈયાર થાય છે. જો આપણે એ નક્કી કરવું હોય કે કયો ઈનપુટ (અનુભવ) આપવાથી ઇચ્છિત પરિણામ (આઉટપુટ) મળશે તો આપણે ANN નો ઉપયોગ કરીને સક્રિય વિધેય બનાવવું પડશે. આ પ્રકરણમાં શિક્ષક પ્રશિક્ષણ અંતર્ગત તાલીમના વિવિધ તબક્કાઓ દરમિયાન ન્યુરોન્સ વચ્ચેના આવા જોડાણો તૈયાર કરવામાં ANN ની સંભવિત ભૂમિકા વિષે વાત કરવામાં આવી છે.

ચાવીરૂપ શબ્દો: આર્ટિફિશિયલ ન્યુરલ નેટવર્ક (ANN), શિક્ષક પ્રશિક્ષણ, સક્રિયકરણ વિધેય, ન્યુરોન

પ્રસ્તાવના:

ANN એ એક પ્રકારનો ઈનપુટ્સ નો એવો ગણ છે કે જેના દ્વારા ઇચ્છિત આઉટપુટ મેળવી શકાય છે. શિક્ષક પ્રશિક્ષણ કાર્યક્રમ કૌશલ્યોના વિકાસ પર કેન્દ્રિત છે. આ કૌશલ્યો શારીરિક, મનોશારીરિક, વર્તનકેન્દ્રી, અધ્યાપનશાસ્ત્રીય, બોધાત્મક, ભાવાત્મક, માનવતાવાદી વગેરે હોઈ શકે છે. આ પૈકી કેટલાક કૌશલ્યો સતત કેટલાક ઈનપુટ્સ આપીને તેના મહાવરા થકી જ વિકસાવી શકાય છે. જેમ કે બોર્ડ પર લખવાનું કૌશલ્ય. આ કૌશલ્યનો વિકાસ નિદર્શન, મહાવરો, પ્રતિપોષણ જેવા ઈનપુટ્સના મહાવરા થકી વિકસાવી શકાય છે. રજૂ કરવામાં આવેલ ઈનપુટ્સ પૈકી કેટલાક ઈનપુટ તરફ પ્રશિક્ષણાર્થીઓને આકર્ષી શકતા નથી જ્યારે અન્ય કેટલાક ઈનપુટ્સ તેઓને આકર્ષીને અધ્યયનમાં મહત્વની ભૂમિકા ભજવે છે. જે ઈનપુટ્સ પ્રશિક્ષણાર્થીઓના અધ્યયનમાં મહત્વની ભૂમિકા ભજવે છે તેની ઓળખ કરીને એક એવું વિધેય (function) બનાવી શકાય છે કે જેના થકી પ્રશિક્ષણાર્થીઓને જરૂરી કૌશલ્યોને અસરકારક રીતે શીખવી શકાય. આ પ્રકારનું સક્રિય વિધેય ઓળખવાથી શિક્ષક પ્રશિક્ષણમાં ANN નો ઉપયોગ કરવાની સંભાવનાઓ વિસ્તારી શકાય છે. પ્રસ્તુત પ્રકરણમાં ANN થકી આ પ્રકારના વિધેયની રચના અંગેની ચર્ચા કરવામાં આવી છે.

❖ **અગાઉ થયેલ અભ્યાસોની સમીક્ષા:**

ANN નો ઉપયોગ હાલમાં અનેક ક્ષેત્રોમાં રહેલા પડકારોનું અનુમાન કરીને તેને ઉકેલવામાં થઈ રહ્યો છે અને આ જ સંદર્ભમાં તેનો ઉપયોગ વિદ્યાર્થીઓના શૈક્ષણિક દેખાવ સામે રહેલા પડકારો તેમજ તેમાં વધારો કરવા માટે પણ થઈ રહ્યો છે (Figueiredo, 2019). કોઈ પ્રક્રિયા માટેના ઈનપુટ્સ નક્કી કરીને આઉટપુટની આગાહી કરવા માટે ANN ના ઉપયોગ અંગે થયેલા કેટલાક અભ્યાસો નીચે દર્શાવેલ છે.

- 1) Marques et al., (2015) એ પોતાના અભ્યાસ ‘વિદ્યાર્થીઓના ભવિષ્યલક્ષી દેખાવની આગાહી કરવામાં ન્યુરલ નેટવર્ક્સનો ઉપયોગ’ દરમિયાન જોયું કે ANN લગભગ 95% જેટલી સચોટ આગાહી કરી શકે છે.
- 2) Hussain (2019) પોતાના અભ્યાસ ‘Using machine learning to predict student difficulties from learning session data’ માં શોધ્યું કે અલ્ગોરિધમ કરતાં ANN વધારે ચોક્કસઈપૂર્વક પરિણામ આપે છે. આ અભ્યાસનો મુખ્ય હેતુ ડિજિટલ ડિઝાઈન કોર્સના લેક્ચર દરમિયાન વિદ્યાર્થીઓને પડનારી સંભવિત મુશ્કેલીઓ અંગેની ભવિષ્યવાણી કરવાનો હતો.
- 3) Musso (2013) ના અન્ય એક અભ્યાસ ‘Predicting general academic performance and identifying the differential contribution of participating variables using artificial neural networks’ માં તેઓને જાણવા મળ્યું કે ત્રણ પૈકીનાં બે મોડેલ વિદ્યાર્થીઓની ઓળખ કરવામાં 100% સાચા પડ્યા હતા જ્યારે ત્રીજું મોડેલ 87% જેટલી ચોક્કસઈ સુધી પહોંચી શક્યું હતું. આ ઉપરાંત ANN દ્વારા અપેક્ષિત નિષ્પત્તિની વિવિધ કક્ષાઓની સમજ કેળવવા માટે જરૂરી યાવીરૂપ ઘટકો અંગેની માહિતી પણ પૂરી પાડવામાં આવી હતી. આ અભ્યાસના પરિણામ સ્વરૂપે ચોક્કસ શૈક્ષણિક દેખાવની વિવિધ કક્ષાઓ પર આપેલ ચલોના તરેહોની કોઈ ચોક્કસ અસરને ઓળખી શકાય છે.

તેનાથી વૈયક્તિક અધ્યયન પ્રક્રિયા પર મહત્તમ અસર કરતાં ચલોની ઓળખ સહેલાઈથી કરી શકાય છે, તેમજ વિવિધ શૈક્ષણિક કક્ષાઓની પ્રાપ્તિ દરમિયાન અસર કરતાં પરિબલોની ઓળખ પણ થઈ શકે છે.

- 4) Musso (2020) એ પોતાના અભ્યાસ ‘Predicting key educational outcomes in academic trajectories: a machine-learning approach’ શોધ્યું કે વિવિધ શૈક્ષણિક નિષ્પત્તિઓના વર્ગીકરણમાં પરંપરાગત પદ્ધતિઓ અને અભિગમો કરતાં ANN જેવા મશીન લર્નિંગ અભિગમનો ઉપયોગ ખૂબ અસરકારક જોવા મળે છે.
- 5) Borhani, Kurosh (2023) દ્વારા ‘An artificial neural network for exploring the relationship between learning activities and student’s performance.’ વિષય પર કરવામાં આવેલ એક અભ્યાસમાં જોવા મળ્યું કે વર્ગખંડ હાજરી, ઊંઘની ગુણવત્તા, અને વ્યાખ્યાન દરમિયાન થતી પ્રશ્નોત્તરી જેવા ઇનપુટ્સ દ્વારા ઊંચું પરિણામ પ્રાપ્ત કરી શકાય છે.

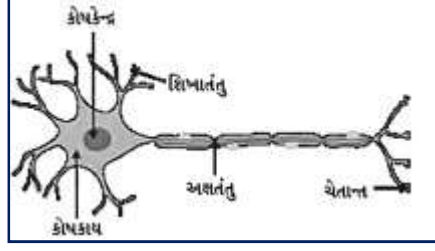
આમ, ઉપરોક્ત અભ્યાસો અપેક્ષિત નિષ્પત્તિ પ્રાપ્ત કરવા માટે ઇનપુટ ચલોની ઓળખ કરવામાં ANN ની અસરકારકતા સાબિત કરે છે. શિક્ષક પ્રશિક્ષણ દરમિયાન ઇચ્છિત વર્તન પ્રાપ્ત કરવા માટે જરૂરી ઇનપુટ્સની ઓળખ કરવામાં ANN ની ભૂમિકા અંગે અહીં વિચારણા કરેલ છે.

આર્ટિફિશિયલ ન્યુરલ નેટવર્ક (ANN):

સૌપ્રથમ ANN શું છે તે સમજવું જરૂરી છે. ANN પાયાના એકમ તરીકે કૃત્રિમ ન્યુરોન્સ ધરાવે છે. આ એકમો એકબીજા સાથે જોડાયેલ હોય તેવા શ્રેણીબદ્ધ સ્તરો રચે છે. જ્યારે આપણે કોઈ ચોક્કસ આઉટપુટ પ્રાપ્ત કરવા માંગીએ છીએ ત્યારે તે માટેના જરૂરી ઇનપુટ્સ ઓળખવા જરૂરી બને છે. જેમ કે, પ્રશિક્ષણાર્થી કોઈ શૈક્ષણિક સાધનનું યોગ્ય નિદર્શન કરે એ અપેક્ષિત આઉટપુટ હોય તો તેને કેવા ઇનપુટ્સ આપવા જરૂરી બને? આ પ્રકારે કોઈ અપેક્ષિત આઉટપુટ મેળવવા માટેના જરૂરી ઇનપુટ્સ ઓળખીને એક મોડેલ ઊભું કરવામાં ANN ની ભૂમિકા અંગેના અનેક અભ્યાસો થયા છે. તે કોઈ પ્રક્રિયાના પરિણામોની આગાહી કરવામાં પણ મદદરૂપ થાય છે. આપણે જાણીએ છીએ કે અધ્યયન દરમિયાન મગજ મહત્વની ભૂમિકા ભજવે છે. આથી ANN ની શિક્ષક પ્રશિક્ષણમાં ભૂમિકા સમજવા માટે નીચેના જેવા શબ્દોની સમજ કેળવવી જરૂરી છે.

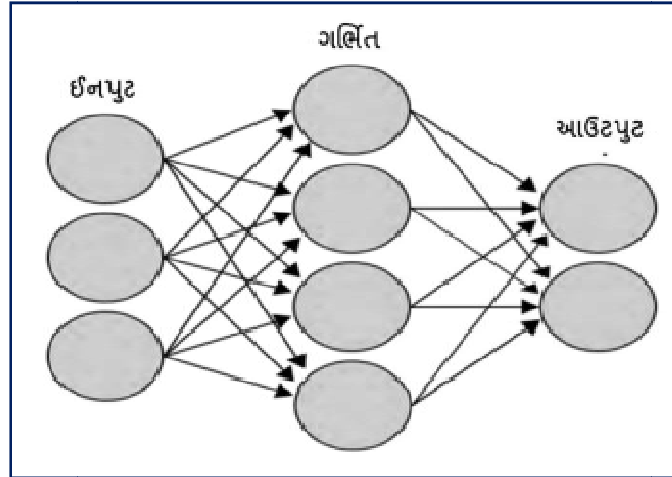
- (1) **ન્યુરોન્સ (ચેતાકોષો):** મગજ અને ચેતાતંત્રની કાર્યપદ્ધતિ તેના સૌથી પાયાનો એકમ એટલે કે ન્યુરોન પરથી સમજી શકાય છે (Squire, 2008). માનવ મગજમાં રહેલ જૈવિક ચેતાકોષની રચના નીચેની આકૃતિ – 1 માં દર્શાવેલ છે. આ ચેતાકોષમાં રહેલ શિખાતંતુ (dendrite) ઇનપુટ તરીકે વર્તે છે. ઇનપુટ મળતા જ એક રાસાયણિક પ્રક્રિયા દ્વારા વિદ્યુતઆવેગ (electric impulse) ઉત્પન્ન થાય છે. આ આવેગ શિખાતંતુથી કોષકાય તરફ આગળ વધે છે. તે અક્ષતંતુ (axon) થઈને ચેતાન્ત તરફ જાય વધે છે. આ પ્રક્રિયા દરમિયાન ચેતોપાગમ (synapses) એ હવે પછીના ન્યુરોનના શિખાતંતુમાં વિદ્યુતઆવેગ ઊભો કરે છે એટલે કે ચેતોપાગમનું આઉટપુટ તેની સાથે જોડાયેલ ન્યુરોન્સ માટે ઇનપુટ બને છે. આ રીતે ન્યુરોન્સ આસપાસના વાતાવરણમાંથી ઇનપુટ મેળવે છે અને તેના પર પ્રક્રિયા કરીને આઉટપુટ તૈયાર કરે છે. આ આઉટપુટ હવે પછીના ન્યુરોન માટે ઇનપુટ બને છે.

મગજના આ ન્યુરોન્સની કાર્યપદ્ધતિ ANN ના કૃત્રિમ ન્યુરોન્સની કાર્યપદ્ધતિ માટેનો આધાર બને છે. તેમાં આર્ટિફિશિયલ ન્યુરોન્સનો સમાવેશ થાય છે કે જે પાયાના એકમ તરીકે વર્તે છે.



આકૃતિ-1 : જૈવિક ચેતાકોષ (ધોરણ-10 વિજ્ઞાન પાઠ્યપુસ્તક, GSEB)

(2) સ્તરો (Layers): આર્ટિફિશિયલ ન્યુરોન્સ ક્રમબદ્ધ રીતે ગોઠવાઈને સ્તરો બનાવીને છેવટે ANN તૈયાર કરે છે. કોઈ એક સ્તરમાં લાખોની સંખ્યામાં ન્યુરોન્સ હોઈ શકે છે. ન્યુરોન્સની આ સંખ્યા અધ્યયન હેઠળ રહેલ બાબતની સંકુલતા પર આધાર રાખે છે. આકૃતિ - 2 માં દર્શાવ્યા અનુસાર ANN માં સામાન્ય રીતે ઈનપુટ, ગર્ભિત અને આઉટપુટ સ્તરો જોવા મળે છે.



આકૃતિ-2 આર્ટિફિશિયલ ન્યુરલ નેટવર્કમાં રહેલા સ્તરો (Burnett, 2006)

- (3) જોડાણો (Connections): ન્યુરોન્સ એક સ્તરમાંથી બીજા સ્તરમાં આંતરજોડાણો ધરાવે છે. દરેક જોડાણ પોતાનો ભારાંક ધરાવે છે કે જે એક ન્યુરોનની બીજા ન્યુરોન પરની અસર નિર્ધારિત કરે છે. જેમ-જેમ માહિતી એક ન્યુરોનમાંથી બીજા ન્યુરોનમાં જાય છે તેમ-તેમ મગજ તે માહિતી વિષે વધારેને વધારે શીખતું જાય છે. આ પ્રક્રિયાનું પરિણામ એટલે બીજા સ્તર માટેનું આઉટપુટ.
- (4) ચેતોપાગમ (Synapsis): જૈવિક ચેતાકોષોમાં ચેતોપાગમ બે કોષો વચ્ચેની એવી કડી છે કે જે આવેગોને શિખાતંતુમાંથી કોષકાયમાં લઈ જવાનું સંભવ બનાવે છે. જ્યારે ANN માં ચેતોપાગમ એક પ્રકારનો ભારાંક છે કે જે એક સ્તરના ચેતાકોષોને બીજા સ્તરના ચેતાકોષો સાથે જોડે છે. આ જોડાણ કેટલું મજબૂત છે તે તેના ભારાંકમૂલ્યને આધારે નક્કી થાય છે.
- (5) અધ્યયન: જૈવિક ચેતાકોષોમાં કોષકેન્દ્રમાં અધ્યયન નિર્માણ પામે છે. તેમાં રહેલ કોષકેન્દ્ર સંવેગો પર પ્રક્રિયા કરવામાં મદદ કરે છે. તેના આધારે તૈયાર થયેલ વિદ્યુતસંવેગ અક્ષતંતુ (axon) દ્વારા

પછીના ચેતાકોષમાં પ્રસરણ પામે છે. આ વિદ્યુતસંવેગ જેટલો તીવ્ર એટલું અધ્યયન વધુ મજબૂત. ANN માં અધ્યયન માટે પ્રતિપ્રસરણ (backpropagation) પ્રયુક્તિનો ઉપયોગ કરવામાં આવે છે. આ પ્રયુક્તિમાં વિવિધ ચેતાકોષો વચ્ચે થતી આપલેમાં રહેલ ભૂલ કે પછી ઇચ્છિત અને વાસ્તવિક આઉટપુટ વચ્ચે રહેલા તફાવતને આધારે ફેરફાર કરવામાં આવે છે. આ ફેરફાર ઈનપુટમાં કરવામાં આવે છે. નબળા ઈનપુટને સ્થાને વધારે ભારાંક ધરાવતો ઈનપુટ રજૂ કરવામાં આવે છે. ઉદાહરણ તરીકે, આકૃતિ (ઈનપુટ-1) ના આધારે હૃદયની કાર્યપદ્ધતિ સમજાવવાથી ઇચ્છિત પરિણામ મેળવવામાં મુશ્કેલી ઊભી થતી હોય તો 3'D એનિમેશન ધરાવતો વિડીયો (ઈનપુટ – 2) રજૂ કરીને પડતી મુશ્કેલી દૂર કરીને ઇચ્છિત અને વાસ્તવિક આઉટપુટ વચ્ચેનો ભેદ ઓછો કરવામાં આવે છે.

(6) **સક્રિયકરણ વિધેય (Activation Function):** જૈવિક ચેતાકોષોમાં સંવેગોની તીવ્રતા મહત્તમ હોય ત્યારે ચેતાકોષોના વિદ્યુતસંવેગોનો દર સક્રિયકરણ દર્શાવે છે. એટલે કે કોઈ એવો સંવેગ પ્રાપ્ત થાય કે જેનાથી ચેતાકોષો તીવ્ર વિદ્યુતસંવેગો પેદા કરે ત્યારે તેને સક્રિયકરણ કહે છે. ANN માં સક્રિયકરણ વિધેય એટલે કે ગાણિતિક વિધેય તૈયાર કરવામાં આવે છે. આ માટે ઈનપુટ અને આઉટપુટની ગણતરીઓ કરવામાં આવે છે. જ્યારે કોઈ ઈનપુટ માટે અનેક આઉટપુટ સંભવ હોય અને આપણે તેને કોઈ એક ચોક્કસ આઉટપુટ સુધી મર્યાદિત કરવું હોય ત્યારે સક્રિયકરણ વિધેયનો ઉપયોગ કરવામાં આવે છે. ઇચ્છિત આઉટપુટ પ્રાપ્ત કરવા માટે સંખ્યાબંધ માહિતી પૂરી પાડવામાં આવે છે. ઇચ્છિત આઉટપુટ મેળવવા માટે સંકુલ ઈનપુટને નાના-નાના પ્રકારો (tasks) માં વહેંચી નાંખવામાં આવે છે. ઉદાહરણ તરીકે, મહત્વના મુદ્દાઓ પર ધ્યાન કેન્દ્રિત કરવા માટે બોર્ડ પર યોગ્ય જગ્યાએ રંગીન ચોક વાપરવા માટેની તાલીમ આપવામાં આવી હોય તો તે વિધેય બની જાય છે અને જ્યારે પણ કોઈ મહત્વનો મુદ્દો આવે છે ત્યારે રંગીન ચોક વાપરવા માટે આ વિધેય સક્રિય બને છે. ગભિર સ્તર ઈનપુટ સ્તરમાંથી ઈનપુટ મેળવે છે તેનો ભારાંક નક્કી કરીને તેને આગળના સ્તર સુધી પહોંચાડે છે. ન્યુરલ નેટવર્કને આ રીતે ઈનપુટ્સ પૂરા પાડીને તાલીમ આપવામાં આવે છે.

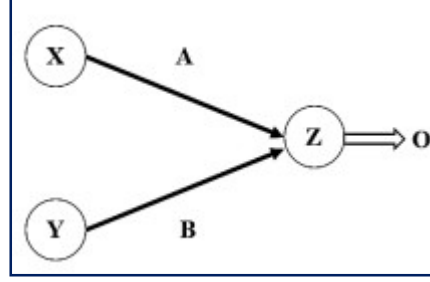
ઉપરોક્ત ચર્ચાના આધારે ANN ના લક્ષણો નીચે મુજબ દર્શાવી શકાય.

- 1) તે ચેતાકોષીય કક્ષાએ લાગુ પાડવામાં આવતું ગાણિતિક મોડેલ છે.
- 2) તેમાં એકબીજા સાથે જોડાયેલ કૃત્રિમ ચેતાકોષો તમામ પ્રક્રિયાઓ કરવા માટે મોટી સંખ્યામાં ભાગ લે છે.
- 3) ચેતાકોષોમાં સંગ્રહિત માહિતી મૂળભૂત રીતે ચેતાકોષો વચ્ચેના ભારાંકિત જોડાણો હોય છે.
- 4) જોડાણો થકી ઈનપુટ સિગ્નલ અને તેની સાથે સંલગ્ન ભારાંક આગળ વધે છે.
- 5) તે આપેલ માહિતીને આધારે ભારાંકોમાં જરૂરી ફેરફારો કરીને અધ્યયન, પુનઃ સ્મૃતિ અને સામાન્યીકરણ જેવી ક્ષમતા ધરાવે છે.
- 6) કોઈ એક ચેતાકોષ કોઈ ચોક્કસ માહિતી ધરાવતો નથી, પરંતુ તમામ ચેતાકોષોનું સંયુક્ત વર્તન તેઓની ગાણિતિક શક્તિ દર્શાવે છે.

❖ **ANN માં સક્રિય વિધેય નિર્માણની પ્રક્રિયા:**

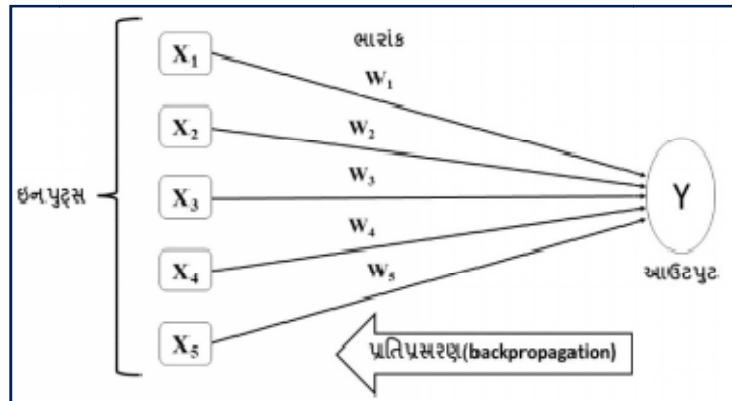
ANN માં સક્રિય વિધેયની રચના જોતાં પહેલા સાદા જૈવિક ન્યુરોનમાં કઈ રીતે કાર્ય થાય છે તે સમજીએ. નીચેની આકૃતિ-3 પરથી જોઈ શકાય છે કે કુલ ત્રણ ન્યુરોન X, Y અને Z આપવામાં આવેલ છે. બે ન્યુરોન X અને Y ન્યુરોન Z ને સિગ્નલ પૂરું પાડી રહ્યા છે. તેથી X અને Y એ ન્યુરોન Z ને ઈનપુટ્સ પૂરા

પાડનાર ન્યુરોન કહી શકાય. એટલે કે Z એ X અને Y ન્યુરોનના આઉટપુટ મેળવતો ન્યુરોન બનશે. આ સમગ્ર ગોઠવણીમાં ન્યુરોન Z ને ન્યુરોન X અને Y ન્યુરોન તરફથી મળતા અંતિમ ઇનપુટને $I = X*A + Y*B$ તરીકે દર્શાવી શકાય. અહીં A અને B એ કમશ: ન્યુરોન X અને Y તરફથી ન્યુરોન Z ને મળતા ઇનપુટની તીવ્રતા છે. આગળ જતાં ન્યુરોન Z પોતે મેળવેલ ઇનપુટસના આધારે આઉટપુટ O તૈયાર કરે છે. આ આઉટપુટ $O = f(I)$ તરીકે દર્શાવી શકાય, જ્યાં I એ ન્યુરોન X અને Y નો અંતિમ ઇનપુટ છે. આમ, સમગ્ર પ્રક્રિયાને ધ્યાનપૂર્વક જોવામાં આવે તો કોઈપણ ન્યુરોન પોતે ઇનપુટ પ્રાપ્ત કરે છે તેમજ આઉટપુટ તૈયાર કરે છે. તૈયાર થતો આઉટપુટ એ ઇનપુટ અને તેની તીવ્રતા પર આધાર રાખે છે.



(આકૃતિ- 3 : જૈવિક ચેતાકોષમાં થતી પ્રક્રિયા)

સક્રિય વિધેય નિર્માણ એ ANN ની મુખ્ય પ્રક્રિયા છે. સક્રિય વિધેય નિર્માણ દરમિયાન ઇનપુટ સ્તરને કેટલાક ઇનપુટસ આપીને ઇચ્છિત આઉટપુટ સુધી પહોંચવામાં આવે છે. જે ઇનપુટસ તેમાં મહત્વનો ફાળો આપે તેને વધારે ભારાંક આપવામાં આવે છે. સક્રિય વિધેય એટલે એક એવું સમીકરણ કે જેમાં કોઈ ચોક્કસ આઉટપુટ મેળવવા માટે ચોક્કસ ભારાંક ધરાવતા ઇનપુટસ આપવામાં આવે છે. આ વિધેય સ્થાપિત કરતી વખતે જુદા-જુદા ઇનપુટ પૂરા પાડીને તે દરેકની તીવ્રતા એટલે કે ભારાંક નિર્ધારિત કરવામાં આવે છે. જરૂર પડ્યે ઇનપુટસમાં ફેરફાર કરીને ચોક્કસ આઉટપુટ સુધી પહોંચવામાં આવે છે. જે ઇનપુટસ વડે ચોક્કસ આઉટપુટ સુધી અસરકારક રીતે પહોંચી શકાય છે તેને પસંદ કરીને સક્રિય વિધેય રચવામાં આવે છે. સક્રિય વિધેય નિર્માણની પ્રક્રિયા નીચેની આકૃતિ - 4 અને તેના આધારે આપેલ તબક્કાઓ દ્વારા સમજી શકાય છે. નીચે દર્શાવ્યા મુજબ બે સ્તરો ધરાવતું સાદું ANN લઈએ તો,



આકૃતિ- 4 ANN માં સક્રિય વિધેય નિર્માણની પ્રક્રિયા

જ્યાં

- X_1, X_2, X_3, X_4, X_5 ઇનપુટસ અને Y આઉટપુટ

- W_1, W_2, W_3, W_4, W_5 અનુક્રમે ઇનપુટ્સ X_1, X_2, X_3, X_4, X_5 ઇનપુટ્સના ભારાંક
- ઇનપુટ સ્તરને X_1, X_2, X_3, X_4 અને X_5 જેવા અનેક ઇનપુટ્સ આપવામાં આવે છે.
- X_1, X_2, X_3, X_4 અને X_5 ઇનપુટ માટે સિસ્ટમને બહોળા પ્રમાણમાં માહિતી પૂરી પાડવામાં આવે છે.
- શરૂઆતમાં દરેક ઇનપુટ માટે યાદ્રચ્છિક રીતે ભારાંક W_1, W_2, W_3, W_4 અને W_5 નક્કી કરવામાં આવે છે.
- ત્યારબાદ ઇનપુટ્સ અને તેના ભારાંકને આધારે સક્રિયકરણ વિધેય બનાવવામાં આવે છે.

$$Y = X_1W_1 + X_2W_2 + X_3W_3 + X_4W_4 + X_5W_5 + B$$

$$Y = \sum X_iW_i + B$$

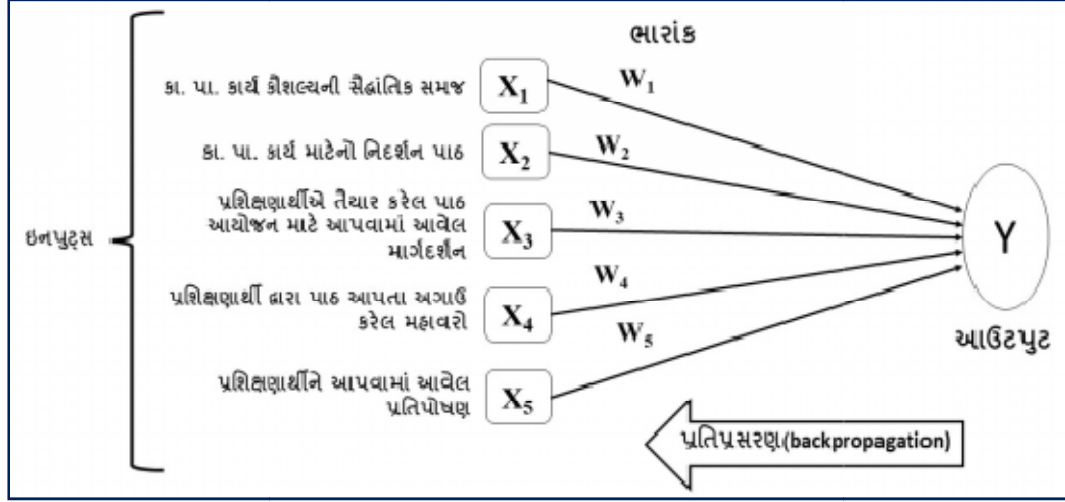
- બધાજ ભારાંકોનો સરવાળો શૂન્ય થવાના સંજોગોમાં આઉટપુટ શૂન્ય ન થાય તે માટે સક્રિયકરણ વિધેયમાં બાયસ વેલ્યુ B ઉમેરવામાં આવે છે.
- જેમ-જેમ માહિતી પ્રાપ્ત થાય તેમ-તેમ ભારાંકમાં ફેરફાર કરવામાં આવે છે.
- સારો ભારાંક ધરાવતો ઇનપુટ ઇચ્છિત આઉટપુટ આપે છે.
- પૂરા પાડવામાં આવેલા પાંચ ઇનપુટ્સ પૈકી કયો ઇનપુટ ઇચ્છિત આઉટપુટ સુધી લઈ જવામાં સિંહફાળો આપે છે તે નિર્ધારિત કરીને તેનો ભારાંક નક્કી કરવામાં આવે છે.
- જે ઇનપુટ ઇચ્છિત આઉટપુટ સુધી લઈ જવામાં વધારે ફાળો આપે તેને સમગ્ર પ્રક્રિયાના મુખ્ય ઇનપુટ તરીકે ઓળખવામાં આવે છે.
- જે ઇનપુટ ઇચ્છિત આઉટપુટ સુધી પહોંચવામાં નબળો દેખાવ કરે છે તેમાં જરૂરી ફેરફારો કરીને તેની અસરકારકતા પુનઃ ચકાસવામાં આવે છે. (પ્રતિપ્રસરણ)

ઉપરોક્ત બાબતને એક ઉદાહરણ દ્વારા સમજાવે. ધારો કે પ્રશિક્ષણાર્થીઓને ANN થકી પ્રશ્ન પ્રવાહિતા સૂક્ષ્મ કૌશલ્ય અંતર્ગત ‘પડઘા પ્રશ્નો’ ઓળખતાં શીખવવું છે. આ માટે ઇનપુટ્સ તરીકે તેઓની સમક્ષ ‘પડઘા પ્રશ્ન’નો અર્થ અને તેનાં અનેક ઉદાહરણો રજૂ કરવામાં આવે છે. જ્યારે પ્રશિક્ષણાર્થી ‘પડઘા પ્રશ્નો’ અંગે શીખી લે છે ત્યારે તેને આ પ્રકારના પ્રશ્નો ઓળખતા આવડે છે કે નહીં તે ચકાસવા માટે તેની સમક્ષ એક પછી એક પ્રશ્નો રજૂ કરીને ‘પડઘા પ્રશ્ન’ને ઓળખવાનું કહેવામાં આવે છે. જો પ્રશિક્ષણાર્થીનું ANN ‘પડઘા પ્રશ્ન’ ઓળખવામાં ભૂલ કરે તો પ્રતિપ્રસરણ (backpropagation) પ્રયુક્તિની મદદથી ઇનપુટ્સમાં ફેરફાર કરવામાં આવે છે. જે પ્રકારનો પ્રશ્ન પ્રશિક્ષણાર્થીને ભૂલથી પડઘા પ્રશ્ન લાગ્યો કે પછી જે પ્રકારનો પ્રશ્ન ‘પડઘા પ્રશ્ન’ હોવા છતાં તેને ઓળખી ન શક્યો તેવા પ્રશ્નોનો ભારાંક વધારીને પુનઃ જરૂરી ઇનપુટ્સ પૂરા પાડવામાં આવે છે. આ પ્રક્રિયા ત્યાં સુધી ચાલુ રાખવામાં આવે છે કે જ્યાં સુધી પ્રશિક્ષણાર્થીનું ANN ઓછામાં ઓછી ભૂલ સાથે ‘પડઘા પ્રશ્નો’ને ઓળખી શકે.

❖ શિક્ષક પ્રશિક્ષણમાં ANN ના ઉપયોગ માટેનું ઉદાહરણ:

શિક્ષક પ્રશિક્ષણ દરમિયાન પ્રશિક્ષણાર્થીઓ અનેકવિધ કૌશલ્યોને હસ્તગત કરે છે. દરેક કૌશલ્યને કેળવવા માટે કેટલાક અનુભવો ઇનપુટ તરીકે આપવામાં આવે છે. આપવામાં આવેલ અનુભવોના જૂથને

આધારે ANN અંતર્ગત સક્રિય વિધેય સ્થાપિત કરી શકાય છે. નીચે કા.પા. કાર્ય સૂક્ષ્મ અધ્યાપન કૌશલ્ય કેળવવા માટે ANN ના ઉપયોગ માટેનું ઉદાહરણ આપેલ છે.



આકૃતિ - 5 : કા. પા. કૌશલ્ય માટે ANN નો ઉપયોગ

ઉપરની આકૃતિ - 5 પરથી જોઈ શકાય છે કે આઉટપુટ તરીકે પ્રશિક્ષણાર્થીમાં કા.પા. કાર્ય કૌશલ્ય વિકસિત કરવાનો હેતુ રહેલો છે.

- આ માટે ઇનપુટ્સ તરીકે પાંચ અનુભવો X_1 , X_2 , X_3 , X_4 અને X_5 દર્શાવેલ છે. (અત્રે એ નોંધવું જરૂરી છે કે આ પાંચ ઇનપુટ્સ માત્ર ઉદાહરણ સ્વરૂપે છે, આ ઉપરાંત પણ બીજા ઇનપુટ્સ પણ હોઈ શકે છે.)
- શરૂઆતમાં માહિતીનું વિશ્લેષણ થયેલ ન હોવાથી દરેક ઇનપુટ્સના ભારાંક અનુક્રમે W_1 , W_2 , W_3 , W_4 અને W_5 દર્શાવેલ છે. આ ભારાંક અધ્યાપક પોતાના અનુભવોના આધારે નિર્ધારિત કરી શકે છે. જેમ કે, ઇનપુટ X_5 (પ્રશિક્ષણાર્થીને આપવામાં આવેલ પ્રતિપોષણ) વધારે અગત્યનું જણાઈ આવે તો તેને વધારે ભારાંક આપી શકાય છે.
- ત્યારબાદ આ માટે બહોળા પ્રમાણમાં માહિતી એકત્રિત કરવામાં આવે છે. આપેલ ઉદાહરણમાં નીચેની રીતે માહિતી એકત્રિત થઈ શકે છે.
 - 1) પ્રશિક્ષણાર્થીઓનો ખૂબ મોટો નમૂનો લઈ તેઓને આપવામાં આવેલ પાંચ ઇનપુટ્સ પૈકી કયો ઇનપુટ વધારે અસરકારક લાગ્યો અને શા માટે તે અંગે પૂછપરછ કરીને.
 - 2) પ્રશિક્ષણાર્થીઓને કયો ઇનપુટ નબળો લાગ્યો અને શા માટે તે અંગે પૂછા કરીને તે ઇનપુટમાં જરૂરી ફેરફારો કરીને તેની અસરકારકતાની પુનઃ ચકાસણી કરીને.
 - 3) શિક્ષક પ્રશિક્ષકોને પાંચ ઇનપુટ્સ પૈકી કયા ઇનપુટનો ઉપયોગ કરતી વખતે પ્રશિક્ષણાર્થી તરફથી સારો પ્રતિચાર મળ્યો તેની નોંધ કરીને.
- પ્રાપ્ત માહિતી સિસ્ટમમાં આપીને પાંચ પૈકી કયો ઇનપુટ કેટલો અસરકારક છે તે શોધીને તે દરેકને યોગ્ય ભારાંક આપવામાં આવે છે. આ તબક્કે શરૂઆતમાં આપવામાં આવેલ ભારાંકોમાં જરૂરી ફેરફાર કરવામાં આવે છે.

- જે ઈનપુટ ઇચ્છિત આઉટપુટ સુધી પહોંચવામાં નબળો દેખાવ કરે છે તેમાં જરૂરી ફેરફારો કરીને તેની અસરકારકતા પુનઃ ચકાસવામાં આવે છે. જરૂર પડ્યે તેને દૂર કરીને નવો ઈનપુટ પણ ઉમેરી શકાય છે. (પ્રતિપ્રસરણ)
- દરેક ઈનપુટ માટે વાસ્તવિક ભારાંકો પ્રાપ્ત થઈ ગયા બાદ અંતિમ માહિતીના આધારે સક્રિય વિધેય બનાવવામાં આવે છે. $Y = X_1W_1 + X_2W_2 + X_3W_3 + X_4W_4 + X_5W_5 + B$
- એક વખત સક્રિય વિધેય તૈયાર કર્યા બાદ તેનો શિક્ષક પ્રશિક્ષણ દરમિયાન ઉપયોગ કરવાથી કા.પા. કાર્યનું પ્રશિક્ષણ અસરકારક રીતે આપી શકાય છે. જેમ કે, શિક્ષક પ્રશિક્ષકને એ વાતનો ખ્યાલ રહે છે કે ઈનપુટ X_3 નો ભારાંક વધારે હોવાથી વર્ગખંડમાં તેને વધારે સમય આપી શકાય તેમજ આ ઈનપુટ અંગેના વધારે અનુભવો પૂરા પાડી શકાય.

ઉપરની રીતે કોઈ એક કૌશલ્યને પસંદ કરીને તે શીખવવા માટેના જરૂરી અને મહત્વના ઇનપુટ્સ નક્કી કરી શકાય છે. આ ઇનપુટ્સ એક કરતાં વધારે હોઈ શકે છે. પસંદ કરેલ ઇનપુટ્સ પૈકી કેટલાક ઈનપુટ ઇચ્છિત આઉટપુટ સુધી પહોંચવામાં મહત્વની ભૂમિકા ભજવે છે. આવા ઇનપુટ્સનો ભારાંક વધારે હોય છે. જો આવા ઇનપુટ્સ ઓળખી લેવામાં આવે તો અપેક્ષિત આઉટપુટ સરળતા અને સફળતાપૂર્વક પ્રાપ્ત કરી શકાય છે. તેના આધારે ANN અંતર્ગત સક્રિય વિધેય રચી શકાય છે.

❖ સમાપન:

ANN થકી નિર્ધારિત આઉટપુટ મેળવવા માટે કેટલાક અસરકારક ઇનપુટ્સનો ઉપયોગ કરીને સક્રિય વિધેય રચી શકાય છે. શિક્ષક પ્રશિક્ષણ દરમિયાન અનેકવિધ કૌશલ્યોનો વિકાસ કરવામાં આવે છે. કેટલાક કૌશલ્યો વર્તન સાથે તો વળી કેટલાક બૌદ્ધિક કૌશલ્યો હોઈ શકે છે. કેટલાક મહત્વના કૌશલ્યોને પસંદ કરીને આર્ટિફિશિયલ ન્યુરલ નેટવર્ક તૈયાર કરી શકાય છે. જો ANN આધારિત શિક્ષક પ્રશિક્ષણ મોડ્યુલ્સ વિકસિત કરવામાં આવે તો તાલીમની અસરકારકતા વધારી શકાશે. આ પ્રકારના મોડ્યુલ્સ બનાવવા માટે ખૂબ બહોળા પ્રમાણમાં માહિતીની જરૂર પડશે. જો સક્રિય વિધેય સફળતાપૂર્વક બનાવી લેવામાં આવે તો કૌશલ્ય વિકાસની પ્રક્રિયા અસરકારક બનાવી શકાય.

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Digital Storytelling in Teaching as a Technological Integration : A Perspective through NEP 2020

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Abstract

In the rapidly evolving educational landscape, the integration of digital technologies into teaching has become both a necessity and a catalyst for innovation. The National Education Policy (NEP) 2020 emphasizes the infusion of technology in education, advocating for learner-centric pedagogies and the promotion of creativity, critical thinking, and digital literacy. Digital storytelling, a method that blends narrative with multimedia tools, has emerged as a powerful instructional approach aligned with NEP 2020's vision. This chapter explores the concept of digital storytelling, its theoretical foundations, pedagogical significance, technological integration, and its impact on teaching and learning. It further presents real-life case studies and provides a roadmap for its effective implementation in Indian classrooms, fostering holistic and experiential learning.

Keywords: Digital Storytelling, Educational Technology, NEP 2020, Pedagogical Innovation, Student Engagement

Introduction

The 21st-century classroom has undergone a transformative shift with the advent of technology, reshaping the way knowledge is created, delivered, and consumed. As the traditional lecture-based methods give way to more engaging and interactive pedagogies, digital storytelling has surfaced as a versatile educational tool. It combines the ancient art of storytelling with modern multimedia elements such as images, videos, sound, and text, allowing students and teachers to create compelling narratives that support learning objectives (Robin, 2008).

The National Education Policy (NEP) 2020 provides a robust framework for the integration of technology into the Indian education system. It envisions an education

system rooted in Indian values while being responsive to the demands of the digital age (Government of India, 2020). One of its significant mandates is to promote the use of technology in teaching and learning processes. In this context, digital storytelling offers a learner-centered approach that aligns with NEP 2020's goals of fostering critical thinking, creativity, communication, and collaboration.

Concept of Digital Storytelling

Digital storytelling refers to the practice of using digital tools to tell stories. These stories may be personal narratives, historical accounts, reflections, or explanations of academic concepts. Digital storytelling allows for the integration of various media elements including text, graphics, audio, video, and animation, making it an engaging mode of communication (Lambert, 2013).

The key components of a digital story typically include a clear purpose, emotional content, a strong voice, and a coherent structure. According to Robin (2006), digital stories usually range between two to five minutes and are designed to convey meaningful messages in an impactful manner. Unlike traditional storytelling, digital storytelling engages multiple senses and offers opportunities for learners to develop digital fluency and multimodal literacy.

Digital storytelling can be categorized into:

1. Personal narratives – sharing personal experiences or family histories
2. Informative stories – explaining a process or academic concept
3. Historical stories – retelling historical events with multimedia support
4. Reflective stories – focusing on learning experiences and insights

Theoretical Framework

Digital storytelling is rooted in several educational theories that advocate active learning and student engagement. Constructivist theories, particularly those advanced by Piaget and Vygotsky, suggest that learners construct knowledge through experiences and reflection. Digital storytelling, by requiring students to research, write, and produce multimedia content, encourages this construction of knowledge (Jonassen, 1999).

Vygotsky's (1978) social constructivism emphasizes the importance of social interaction in learning. When students collaborate on digital storytelling projects, they negotiate meaning, share perspectives, and co-construct narratives. Moreover, Howard Gardner's theory of multiple intelligences (1983) supports the use of digital

storytelling, as it taps into linguistic, visual-spatial, musical, and interpersonal intelligences.

Pedagogical Approaches to Digital Storytelling

Integrating digital storytelling into pedagogy involves more than just using technology; it requires thoughtful instructional design. Key pedagogical approaches include:

1. **Project-Based Learning (PBL):** Digital storytelling is inherently project-based, enabling students to engage in sustained inquiry and problem-solving.
2. **Inquiry-Based Learning:** Students investigate topics, gather information, and synthesize content into a coherent story.
3. **Reflective Practice:** Teachers and students reflect on experiences, turning them into narrative forms that promote deeper understanding.
4. **Flipped Classroom:** Teachers can use digital stories as pre-class resources, freeing up classroom time for discussion and analysis.
5. **Differentiated Instruction:** Digital storytelling allows for personalization, enabling students of varying abilities to express themselves creatively.

Technological Integration in Digital Storytelling

Effective implementation of digital storytelling requires access to technology and appropriate tools. With the increasing availability of digital devices and internet connectivity, especially in urban Indian classrooms, the potential for integrating such tools has grown.

Common Tools Used:

- **Video Editing Software:** Windows Movie Maker, iMovie, Adobe Premiere
- **Presentation Tools:** Microsoft PowerPoint, Prezi
- **Digital Story Platforms:** Storybird, Book Creator, Adobe Spark
- **Audio Tools:** Audacity, GarageBand

Steps in Creating a Digital Story:

1. Identifying the topic or theme
2. Researching and scripting the story
3. Gathering and organizing multimedia elements
4. Creating the digital story using software tools
5. Sharing and reflecting on the story

The NEP 2020 encourages digital literacy and promotes platforms like DIKSHA and e-Pathshala which can serve as repositories for digital stories created by students and teachers (Government of India, 2020).

Impact on Learning Outcomes

Research has shown that digital storytelling enhances student engagement, motivation, and retention of information. According to Sadik (2008), students involved in digital storytelling projects demonstrate improved communication skills, better understanding of content, and higher-order thinking skills.

Benefits Include:

- Enhanced creativity and expression
- Development of research and organizational skills
- Strengthened technological and digital literacy
- Improved collaboration and teamwork
- Increased student autonomy and motivation

A study by Yang and Wu (2012) indicated that students who engaged in digital storytelling performed better in critical thinking and language proficiency assessments compared to those in traditional classrooms.

Challenges and Recommendations Challenges and Recommendations

Challenges:

1. **Digital Divide:** Many schools, especially in rural and underprivileged areas, lack the necessary infrastructure, including internet access, multimedia devices, and digital literacy among teachers and students.
2. **Teacher Preparedness:** Teachers often lack the training and confidence to implement digital storytelling effectively. Many are unfamiliar with digital tools or are hesitant to deviate from traditional pedagogies.
3. **Curriculum Constraints:** The existing curriculum is often rigid and overloaded, leaving little room for creative and time-intensive approaches like digital storytelling.
4. **Assessment Challenges:** Traditional assessment methods do not always capture the learning outcomes of digital storytelling, such as creativity, collaboration, and digital fluency.
5. **Language and Accessibility Barriers:** Digital storytelling resources and tools are often in English, limiting their usability among regional language speakers and differently-abled learners.

Recommendations:

1. **Infrastructure Development:** Government and private partnerships should work towards improving digital infrastructure, especially in rural and underserved areas. Equipping classrooms with multimedia devices and reliable internet is essential.
2. **Teacher Training:** Professional development programs focusing on digital pedagogy and storytelling tools must be made mandatory in pre-service and in-service teacher training curricula.
3. **Curriculum Integration:** Education boards should integrate digital storytelling into subject syllabi and offer flexible modules that accommodate innovative teaching methods.
4. **Innovative Assessment Models:** Develop rubrics and alternative assessment tools to evaluate digital storytelling projects. This can include peer reviews, reflective journals, and portfolio assessments.
5. **Multilingual and Inclusive Tools:** Encourage the development of digital storytelling tools in regional languages and accessible formats to ensure inclusivity.
6. **Community and Parental Engagement:** Engage parents and local communities in digital storytelling projects to create culturally relevant narratives and reinforce community values.

Conclusion

Digital storytelling stands at the intersection of technology, pedagogy, and creativity. As India embraces the vision of NEP 2020, integrating digital storytelling in teaching practices offers a pathway to foster deeper learning, digital competence, and 21st-century skills. By empowering students to become creators of content, not just consumers, we move closer to realizing an education system that is inclusive, innovative, and future-ready.

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Competencies for 21st century teachers

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Abstract

In the rapidly evolving landscape of education, the role of teachers is undergoing a profound transformation. This chapter explores the essential competencies required for 21st-century educators to navigate the complexities of modern classrooms and prepare learners for a dynamic, interconnected world. It examines five core domains of teacher competencies: pedagogical knowledge, technological proficiency, cultural competence, collaboration and communication skills, and emotional intelligence. Each domain is analyzed in depth, emphasizing its relevance in fostering inclusive and effective learning environments. The chapter highlights challenges such as access to resources, resistance to change, and the need for systemic support. It proposes strategies for developing these competencies, including targeted professional development, mentorship programs, and integration of these skills into teacher preparation curricula. Real-world examples illustrate successful implementations of these strategies in diverse educational contexts, offering actionable insights for policymakers, educators, and institutions.

Emerging trends such as artificial intelligence, global citizenship education, and personalized learning are discussed, shedding light on future directions for teacher preparation. The chapter concludes with a call for collaborative efforts among stakeholders to prioritize and sustain the development of these competencies, ensuring that teachers are equipped to inspire and lead the next generation. By addressing the multifaceted demands of contemporary education, this work contributes to the ongoing discourse on redefining teacher excellence in the 21st century.

Key Words : *Competencies, Artificial Intelligence, Global Citizenship Education, Personalized Learning*

Introduction

The 21st century is characterized by rapid advancements in technology, shifting global dynamics, and evolving societal needs. In this context, education must prepare students to thrive in an unpredictable and interconnected world (Darling-Hammond et

al., 2020). Central to this mission is the role of teachers, whose responsibilities now extend beyond delivering content knowledge to fostering critical thinking, creativity, collaboration, and empathy among learners. This shift necessitates a reimagining of teacher competencies, emphasizing adaptability and holistic development.

Historically, the teaching profession has been viewed as a knowledge-centric role, where expertise in specific subject areas was paramount. However, the challenges of the 21st century, including globalization, climate change, and rapid technological evolution, demand a broader set of skills. Teachers are now expected to cultivate not only academic knowledge but also the soft skills necessary for students to navigate a complex world. This chapter outlines the competencies essential for teachers to succeed in this evolving paradigm. It begins with an exploration of five core domains: pedagogical knowledge, technological proficiency, cultural competence, collaboration and communication skills, and emotional intelligence. These domains collectively encapsulate the skills, attitudes, and knowledge teachers need to address diverse student needs and promote equitable learning outcomes.

Subsequent sections address the challenges teachers face in acquiring and applying these competencies, followed by strategies for effective teacher training and development. Case studies illustrate practical applications, while the discussion on future trends highlights the ongoing evolution of the teaching profession. This comprehensive examination aims to equip educators, policymakers, and institutions with a roadmap for fostering teacher excellence in the 21st century.

Core Competencies for 21st-Century Teachers

1. Pedagogical Knowledge

Pedagogical knowledge is the cornerstone of effective teaching, encapsulating the theories, principles, and methodologies that inform instructional practices. In the 21st century, traditional pedagogical approaches are being supplemented by innovative frameworks designed to promote critical thinking, problem-solving, and creativity. Teachers are no longer mere disseminators of knowledge but facilitators of active learning environments.

2. Student-Centered Learning Approaches

Student-centered learning has become a hallmark of 21st-century pedagogy. It emphasizes active participation, where students engage in discussions, projects, and problem-solving activities rather than passively receiving information. Inquiry-based learning, a key component of student-centered approaches, encourages students to ask

questions and explore topics through research and experimentation (Meyer et al., 2014). Teachers must skillfully scaffold learning experiences to align with students' developmental stages and individual interests.

3. Differentiated Instruction

Another critical aspect of pedagogical knowledge is the ability to implement differentiated instruction. Teachers must adapt their strategies to accommodate diverse learning styles, abilities, and cultural backgrounds. For example, visual learners may benefit from graphic organizers and videos, while kinesthetic learners might thrive in hands-on activities. Universal Design for Learning (UDL) frameworks provide a structured approach for creating inclusive classrooms that cater to all learners.

4. Assessment Literacy

Effective teaching also requires robust assessment literacy. Teachers must design formative and summative assessments that accurately measure learning outcomes while providing actionable feedback. Assessment tools, such as rubrics and digital platforms, allow teachers to track student progress and identify areas requiring intervention. Moreover, data-driven decision-making has become integral to modern pedagogy, empowering educators to refine their strategies based on empirical evidence.

5. Interdisciplinary and Real-World Applications

Interdisciplinary approaches connect learning to real-world contexts, making education relevant and engaging for students. For instance, a project on climate change can integrate science, geography, and language arts, encouraging students to analyze data, propose solutions, and present their findings. By bridging academic disciplines, teachers help students develop transferable skills essential for the 21st century.

6. Challenges and Professional Development

While pedagogical knowledge is foundational, its application is not without challenges. Teachers often face constraints such as large class sizes, limited resources, and rigid curricula that hinder the implementation of innovative practices. Professional development programs play a crucial role in addressing these challenges, offering teachers opportunities to learn and refine their pedagogical skills. Peer mentoring, workshops, and online courses are valuable avenues for continuous growth.

Pedagogical knowledge in the 21st century extends beyond content delivery. It encompasses the ability to create inclusive, engaging, and adaptive learning environments that foster critical thinking and holistic development.

Technological Proficiency

Technology has revolutionized education, transforming how teachers deliver content and engage with students. In the digital age, technological proficiency is no longer optional; it is a core competency that enables educators to integrate innovative tools and methods into their teaching.

1. Digital Literacy and Tools

Digital literacy encompasses the ability to use, evaluate, and create digital content responsibly. Teachers must be adept at using tools such as learning management systems (LMS), virtual classrooms, and interactive applications to enhance instruction. Platforms like Google Classroom, Microsoft Teams, and Kahoot enable collaborative and interactive learning experiences.

2. Blended and Hybrid Learning Models

Blended learning combines traditional classroom instruction with online components, offering flexibility and personalization. Teachers must design lessons that effectively integrate in-person and digital elements, ensuring a seamless learning experience. During the COVID-19 pandemic, hybrid models became a necessity, underscoring the importance of teacher proficiency in managing virtual platforms and tools (OECD, 2019).

3. Digital Citizenship

An often-overlooked aspect of technological proficiency is fostering digital citizenship among students. Teachers play a critical role in guiding students on responsible technology use, addressing issues such as cyberbullying, data privacy, and ethical behavior online. This includes teaching students to evaluate information critically, a skill essential in combating misinformation.

4. Professional Development in Technology

Ongoing professional development is crucial for teachers to stay abreast of technological advancements. Workshops, certification programs, and peer learning networks provide opportunities to explore emerging tools and pedagogical strategies. For instance, training in artificial intelligence (AI) and virtual reality (VR) can prepare teachers to create immersive learning environments.

5. Challenges in Technology Integration

Despite its potential, technology integration in education is not without challenges. Inequities in access to devices and internet connectivity create a digital divide, disproportionately affecting marginalized communities. Teachers also face time constraints and steep learning curves when adopting new technologies. Institutional support, such as providing infrastructure and training, is vital for overcoming these barriers.

Hence, technological proficiency empowers teachers to harness the potential of digital tools, creating dynamic and inclusive learning environments. By embracing technology, educators can prepare students for a future defined by innovation and connectivity.

Collaboration and Communication Skills

In the 21st century, teaching is no longer an isolated activity conducted behind closed classroom doors. Instead, it is a dynamic and collaborative profession that requires teachers to work effectively with colleagues, parents, community stakeholders, and students. Collaboration and communication are essential skills that empower teachers to create supportive learning environments, share innovative practices, and foster meaningful relationships. These competencies are critical not only for teaching but also for the broader goals of improving school culture and advancing educational equity (Hargreaves & Fullan, 2012).

1. The Importance of Collaboration in Education

Collaboration among teachers and other stakeholders is essential for addressing the multifaceted challenges of modern education. Effective collaboration allows educators to:

- **Share Knowledge and Expertise:** Teachers can learn from one another by sharing best practices, resources, and strategies. Professional learning communities (PLCs), for example, encourage educators to collaborate on lesson planning, assessment design, and problem-solving.
- **Foster Consistency and Alignment:** Collaboration ensures that instructional approaches are aligned across grade levels and subjects, creating a more coherent learning experience for students. For instance, cross-curricular projects require teachers from different disciplines to work together to design interconnected lessons.

- **Support Diverse Learners:** Teachers can collaborate with special education staff, counselors, and language specialists to develop individualized support plans for students with diverse needs. This team-based approach helps ensure that all students have equitable access to high-quality education.
- **Drive Innovation:** Collaborative environments encourage creativity and experimentation. Teachers who work together are more likely to adopt innovative practices, such as integrating technology into the classroom or developing project-based learning activities.
- **Build School Community:** Collaboration fosters a sense of shared responsibility and purpose among staff members, creating a positive school culture. This culture benefits students, who are more likely to thrive in environments where adults model teamwork and mutual respect.

2. The Role of Communication in Teaching

Communication is a cornerstone of effective teaching and collaboration. Teachers must be able to convey ideas clearly, listen actively, and adapt their communication style to different audiences. Strong communication skills are essential in several key areas:

- **Classroom Management:** Effective communication helps teachers establish expectations, provide feedback, and resolve conflicts. Clear instructions and positive reinforcement contribute to a well-managed classroom environment.
- **Parent-Teacher Relationships:** Building partnerships with parents is critical for supporting student success. Teachers must communicate regularly and transparently with families, using tools such as newsletters, parent-teacher conferences, and digital platforms.
- **Collaboration with Colleagues:** Communication is the foundation of successful collaboration among teachers. Open and respectful dialogue fosters trust and ensures that ideas are shared and implemented effectively.
- **Advocacy for Students:** Teachers often serve as advocates for their students, communicating their needs to administrators, policymakers, and community stakeholders. This role requires persuasive communication skills and the ability to articulate the importance of equity and inclusion.
- **Student Engagement:** Engaging students in meaningful discussions, encouraging their participation, and providing constructive feedback are all

aspects of effective teacher-student communication. These skills help build relationships and promote a positive learning environment.

3. Collaboration Models in Education

Various models of collaboration have emerged as effective frameworks for fostering teamwork among educators and stakeholders. These include:

- **Professional Learning Communities (PLCs):** PLCs are structured groups of educators who meet regularly to discuss student progress, share resources, and plan instruction. Research shows that PLCs improve teacher efficacy and student outcomes by promoting reflective practice and collective problem-solving (DuFour et al., 2016).
- **Co-Teaching:** In co-teaching models, two or more educators share responsibility for planning, delivering, and assessing instruction. This approach is particularly effective in inclusive classrooms, where general education and special education teachers collaborate to meet the needs of all learners.
- **Interdisciplinary Teams:** Teachers from different subject areas collaborate to design cross-curricular lessons or projects. For example, an interdisciplinary project on sustainability might involve science, social studies, and language arts teachers working together to integrate their content areas.
- **Community Partnerships:** Collaboration extends beyond the school to include partnerships with community organizations, businesses, and local governments. These partnerships provide students with real-world learning opportunities and resources that enhance their education.

4. Developing Communication Skills in Teachers

Effective communication is not an innate skill for all teachers; it must be cultivated through training and practice. Key strategies for developing communication skills include:

- **Active Listening:** Teachers should practice active listening, which involves fully focusing on the speaker, understanding their message, and responding thoughtfully. This skill is essential for building rapport with students, colleagues, and parents.
- **Conflict Resolution:** Teachers must learn techniques for resolving conflicts constructively, such as using "I" statements, seeking common ground, and

addressing issues calmly and professionally. Conflict resolution skills are particularly important for managing disagreements among colleagues or addressing behavioral issues in the classroom.

- **Nonverbal Communication:** Nonverbal cues, such as body language, facial expressions, and tone of voice, play a significant role in communication. Teachers should be aware of their nonverbal signals and use them to convey confidence, empathy, and enthusiasm.
- **Digital Communication:** With the increasing use of technology in education, teachers must be proficient in digital communication tools such as email, video conferencing, and learning management systems. Clear and professional digital communication is essential for maintaining effective relationships with students and parents in online or hybrid learning environments.

5. Challenges to Collaboration and Communication

Despite the benefits, teachers face several challenges in developing and maintaining strong collaboration and communication skills:

- **Time Constraints:** Teachers often have limited time for collaboration due to heavy workloads and tight schedules. This can make it difficult to participate in team meetings, PLCs, or co-teaching arrangements.
- **Differing Perspectives:** Collaborating with colleagues who have different teaching styles, philosophies, or priorities can lead to conflicts or misunderstandings. Effective communication is essential for navigating these differences.
- **Lack of Training:** Many teacher preparation programs do not adequately emphasize collaboration and communication skills, leaving educators unprepared for the demands of modern teaching.
- **Institutional Barriers:** Hierarchical structures and rigid school policies can impede collaboration by discouraging teacher autonomy and innovation.

6. Strategies to Foster Collaboration and Communication

To overcome these challenges, schools and educators can implement several strategies:

- **Structured Collaboration Time:** Schools should allocate dedicated time for collaboration, such as weekly team meetings or designated professional

development days. Providing teachers with protected time for collaboration helps ensure its effectiveness.

- **Professional Development:** Training programs focused on collaboration and communication skills can equip teachers with the tools they need to work effectively with colleagues and stakeholders. Role-playing exercises, workshops, and peer coaching are valuable approaches.
- **Leadership Support:** School leaders play a crucial role in fostering a culture of collaboration. By modeling effective communication and encouraging teamwork, administrators can create an environment where collaboration is valued and supported.
- **Technology Integration:** Digital tools, such as shared online workspaces and communication platforms, can facilitate collaboration among teachers, even across different locations. Tools like Google Drive, Slack, or Trello allow for seamless sharing of resources and ideas.

7. Case Studies: Successful Collaboration and Communication Initiatives

Examples of successful collaboration and communication initiatives highlight their transformative potential. For instance, a school district in Canada implemented a PLC model that significantly improved student literacy rates by fostering a collaborative culture among teachers. Similarly, a U.S. high school's interdisciplinary team approach led to increased student engagement and deeper learning outcomes.

Collaboration and communication are indispensable competencies for 21st-century teachers. By working together effectively, educators can create inclusive, innovative, and supportive learning environments that meet the diverse needs of their students. While challenges exist, targeted strategies such as professional development, leadership support, and the integration of digital tools can help teachers develop these skills. As the teaching profession continues to evolve, fostering collaboration and communication will remain a cornerstone of educational success.

Emotional Intelligence and Social-Emotional Learning (SEL)

Emotional intelligence (EI) and social-emotional learning (SEL) are foundational competencies for educators in the 21st century, playing a pivotal role in fostering positive relationships and creating supportive classroom environments. Emotional intelligence is the capacity to understand, regulate, and manage one's own emotions

while empathizing with the emotions of others. SEL extends this by equipping students with essential skills to manage emotions, establish healthy relationships, and make responsible decisions. Teachers, as primary role models, are integral to embedding these practices in daily educational experiences (Goleman, 1995; CASEL, 2021).

Goleman (1995) identifies five key components of emotional intelligence: self-awareness, self-regulation, motivation, empathy, and social skills. Self-awareness involves recognizing one's emotions, strengths, and limitations. Self-regulation refers to managing emotions constructively and adapting to challenges. Motivation is the resilience and persistence to achieve goals despite obstacles. Empathy is the ability to understand and share the feelings of others, which fosters meaningful interpersonal connections. Social skills enable effective communication, conflict resolution, and collaboration. Teachers possessing these qualities are better equipped to create emotionally safe environments where students feel valued, respected, and motivated to learn. High EI allows educators to manage classroom dynamics, address challenges constructively, and cultivate a culture of mutual respect and understanding.

Social-emotional learning complements EI by focusing on how students acquire and apply the knowledge, attitudes, and skills necessary for emotional and social development. CASEL (2021) outlines SEL as the process that enables students to understand emotions, set and achieve goals, develop empathy, build relationships, and make ethical decisions. SEL is embedded in classroom culture, influencing interactions and instruction. For example, incorporating SEL into the curriculum through collaborative projects or ethical discussions fosters skills foundational to academic and lifelong success. The importance of EI and SEL in education is underscored by their far-reaching benefits. Research demonstrates that SEL enhances academic outcomes. A meta-analysis by Durlak et al. (2011) revealed that students participating in SEL programs improved their academic performance by an average of 11 percentile points. Additionally, teachers with high EI contribute to positive classroom environments where behavioral issues decrease, and student engagement flourishes. SEL also addresses mental health concerns, equipping students with strategies to navigate stress and anxiety in an increasingly complex world. Furthermore, EI and SEL promote empathy and conflict resolution, critical for diverse and globalized classrooms. Importantly, EI benefits teachers themselves by reducing burnout and supporting professional well-being, enabling sustained effectiveness.

Developing EI and SEL in teachers requires intentional strategies and institutional support. Self-reflection is a foundational step, allowing educators to recognize emotional triggers, strengths, and growth areas. Practices such as journaling, mindfulness, and peer feedback enhance self-awareness. Professional development programs focusing on EI and SEL equip teachers with the tools to manage emotions, build relationships, and integrate SEL strategies. Experiential learning methods, such as role-playing and case studies, are particularly effective. Additionally, teachers must model SEL skills in their interactions with students, demonstrating empathy, active listening, and conflict resolution. This modeling establishes a framework for students to emulate. Creating safe and inclusive environments is another critical strategy. Teachers can establish clear norms, foster open communication, and respect diversity to ensure students feel comfortable expressing their emotions and opinions. SEL can also be woven into the curriculum through reflective writing, character analysis in literature, and interdisciplinary projects that promote ethical and emotional exploration. For instance, a lesson on empathy might involve analyzing a historical event from multiple perspectives.

However, integrating EI and SEL into teaching is not without challenges. Teachers often face time constraints due to academic demands and high-stakes testing, limiting their capacity to prioritize SEL. Many teacher preparation programs inadequately address these areas, leaving educators unprepared to implement them effectively. Additionally, cultural resistance can hinder SEL adoption, as some communities may perceive it as secondary to academic instruction or incompatible with traditional values. Systemic barriers such as large class sizes and insufficient resources further impede efforts to incorporate SEL meaningfully.

Real-world examples illustrate the transformative impact of SEL when implemented effectively. For instance, the Anchorage School District in Alaska adopted a district-wide SEL initiative that significantly improved academic performance, reduced disciplinary issues, and enhanced teacher satisfaction. The initiative emphasized explicit SEL instruction, curriculum integration, and continuous teacher training. Similarly, the PATHS (Promoting Alternative Thinking Strategies) curriculum has demonstrated success in improving students' emotional regulation and problem-solving skills in schools across the United States and internationally. Organizations like CASEL offer comprehensive frameworks for SEL implementation, emphasizing systemic support and collaboration among stakeholders.

The future of EI and SEL in education reflects a broader shift toward holistic development. Emerging trends include technology-enhanced SEL through apps and digital platforms that facilitate emotional regulation and empathy exercises. Global perspectives are also gaining prominence, with SEL frameworks expanding to incorporate cross-cultural understanding and global citizenship. Furthermore, the integration of SEL with trauma-informed practices addresses the needs of students who have experienced adverse childhood events, ensuring that classroom environments are sensitive to their unique challenges.

Emotional intelligence and social-emotional learning are indispensable for 21st-century teachers. By developing their own EI and fostering SEL in classrooms, educators create environments that support students' academic, social, and emotional growth. Despite challenges, strategies such as professional development, curriculum integration, and systemic support can enable successful implementation. As education evolves, EI and SEL will remain central to preparing students for the complexities of modern life, underscoring their enduring relevance in teaching and learning.

Challenges and Barriers

Teachers face numerous challenges and barriers in developing and applying 21st-century competencies, many of which stem from systemic, institutional, and personal factors. One significant systemic challenge is the unequal distribution of resources across schools, with underfunded institutions often lacking access to technology, training, and materials required for modern teaching (OECD, 2019). This digital divide became particularly evident during the COVID-19 pandemic, as teachers in underserved areas struggled to implement online learning due to limited internet connectivity and outdated equipment.

Institutional constraints further exacerbate these challenges. Rigid curricula and an overemphasis on standardized testing leave little room for creativity or the integration of innovative practices like social-emotional learning (SEL) or culturally responsive teaching. Additionally, professional development opportunities are not uniformly accessible, particularly for educators in rural or remote areas, leading to disparities in teacher preparedness (Darling-Hammond et al., 2017). Personal and psychological barriers also impede progress. Many teachers face high levels of stress and burnout due to heavy workloads, low pay, and insufficient recognition, which can diminish their capacity to engage in professional growth. Resistance to change, particularly

among veteran educators, is another obstacle, often rooted in a lack of confidence in adopting new technologies or pedagogical approaches (Hargreaves & Fullan, 2012).

Cultural resistance and systemic inequities further complicate efforts to implement inclusive teaching practices. For instance, integrating SEL or equity-focused initiatives may face opposition in communities that prioritize traditional educational values or lack awareness of their benefits. Addressing these challenges requires systemic reforms, equitable resource distribution, and sustained professional development tailored to the evolving needs of teachers and schools (Gay, 2018). In summary, overcoming these barriers demands collaborative efforts across policymakers, institutions, and educators to create environments that empower teachers and bridge existing gaps.

Conclusion

The demands of the 21st century require a reimagining of teacher competencies to meet the evolving needs of students and the globalized world. Teachers must now transcend traditional roles, embracing skills that foster critical thinking, creativity, cultural competence, emotional intelligence, and technological proficiency. These competencies are essential not only for academic success but also for equipping students with the tools to navigate complex societal and professional landscapes. This chapter has examined the core competencies essential for modern educators, the barriers they face in developing and applying these skills, and strategies to foster their growth. Systemic challenges such as resource inequities, institutional rigidity, and cultural resistance often hinder progress. However, actionable solutions, including comprehensive teacher preparation programs, sustained professional development, mentorship, and curriculum integration, demonstrate the potential for transformative change when implemented effectively. Case studies from around the world underscore the tangible benefits of prioritizing these competencies, from enhanced student outcomes to improved teacher satisfaction and well-being.

Looking forward, emerging trends such as personalized learning, global citizenship education, and trauma-informed practices highlight the need for adaptability and lifelong learning among educators. Collaborative efforts among policymakers, institutions, and communities are crucial to creating environments where teachers can thrive.

By investing in these competencies, educational systems can empower teachers to inspire and lead the next generation, ensuring that students are prepared to face the

challenges and opportunities of an interconnected and dynamic world. The journey to redefine teacher excellence is both a necessity and a transformative opportunity.

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Integrating Technology and AI in Teacher Training

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Abstract

Over the past five years, I've explored ways to integrate AI into my teaching practice even before ChatGPT and other generative AI became some of the most talked-about topics in education. Every educator needs to learn about AI and how we can leverage this technology to benefit our students and enhance our own work. To best provide for our students, we need to understand how this technology will impact them and us. What better way than to explore new tools via AI in our teaching practice?

The rapid advancement of artificial intelligence (AI) and digital technology is transforming teacher training, equipping educators with cutting-edge tools to enhance learning outcomes. Traditional training methods often struggle to meet the evolving demands of modern classrooms, but AI-powered solutions—such as adaptive learning platforms, real-time analytics, and immersive technologies like virtual and augmented reality—are bridging this gap. These innovations enable personalized training experiences, interactive simulations, and data-driven insights, empowering teachers to refine their instructional techniques and engage diverse learners effectively. AI-driven automation also streamlines lesson planning, assessment, and feedback, allowing educators to focus on creativity and student engagement. Virtual mentors and AI-based coaching systems provide continuous professional development, ensuring that teachers stay ahead in an ever-changing educational landscape. By integrating AI and technology into teacher training, institutions can create a more dynamic, efficient, and impactful learning ecosystem.

This chapter explores the transformative potential of AI in teacher training, addressing key benefits, challenges, and best practices. As education continues to evolve, embracing AI-driven methodologies will be essential for preparing teachers to inspire and guide the next generation of learners.

Keywords: Integrating, Technology AI, Teacher Training

Introduction

“Artificial Intelligence (AI) has the potential to influence practically every aspect of education and society as it rapidly expands both inside and outside of school.” AI will play an increased role in personalizing education, supporting curriculum development, and encouraging experimentation with new styles of teaching and learning.

In the rapidly evolving educational landscape, technology and artificial intelligence (AI) are transforming teacher training by enhancing instructional methods, personalizing learning experiences, and improving efficiency. AI-powered tools, such as virtual simulations, adaptive learning platforms, and real-time feedback systems, are equipping educators with innovative teaching strategies. These advancements help teachers develop essential skills, stay updated with modern pedagogical approaches, and address diverse classroom needs. By integrating AI and technology into training programs, educators can foster more engaging, effective, and student-centered learning environments.

As with the introduction of any new technology, AI’s capabilities must be welcomed with caution. Meanwhile, AI offers limitless opportunities. These include new forms of interaction—which can be particularly groundbreaking for special education programs and multilingual learners—to facilitate communication, personalized learning adaptations, improved feedback loops, and individualized tutoring with “study buddies” are just a few ways that AI is transforming the K-12 landscape.

The education sector is undergoing a massive transformation with the rise of artificial intelligence (AI) and digital technologies. Teacher training, a crucial aspect of educational effectiveness, must evolve to incorporate AI-driven methodologies and technological advancements. Traditional training programs, often limited to theoretical approaches, are being replaced by dynamic, data-driven, and interactive learning environments. The integration of AI and technology in teacher training enhances professional development, offers personalized learning experiences, and equips educators with the tools necessary for 21st-century classrooms. This chapter explores the role of AI and technology in teacher training, key innovations, benefits, challenges, and future directions.

When Was AI First Used in Education?

Backed by research from Britannica Education, we know that the first AI program was written in 1951. In the 1950s, British logician and computer pioneer Alan Turing

“questioned whether a machine has the ability to think and introduced central concepts of AI.... In subsequent decades, technology continued to advance globally, making its way into the classroom.”

As the technology made its way to the classroom within the following decades, AI has proven to be transformative for analytics in K-12 education, and this increased use of AI-powered tools will continue to unlock teaching and learning opportunities for the education ecosystem.

Artificial Intelligence in Current Education

The mention of artificial intelligence brings to mind a supercomputer, a computer with immense processing capabilities, including adaptive behavior, such as inclusion of sensors, and other capabilities, that enable it to have human-like cognition and functional abilities, and indeed, which improve the supercomputers interaction with human beings. Indeed, different motion pictures have been made to showcase the abilities of AI, such as in smart buildings, such as the ability to manage air quality in a building, temperatures, and or playing music depending on the sensed mood of the occupants of the space. Within the education sector, there has been increased application of artificial intelligence, going over and above the conventional understanding of AI as a supercomputer to include embedded computer systems.

For example, embedded into robots, AI, or computers and supporting equipment enable the creation of robots that improve the learning experience of the student, from the most basic unit of education, early childhood education. Indeed, Timms posited that robots or the application of robots, working together with teachers or colleague robots are being applied to teach children routine tasks, including spelling and pronunciation and adjusting to the students’ abilities. Similarly, the web-based and online education, as enumerated in different studies, has transitioned from simply availing materials online or on the web for students to simply download, study, and do assignments to just pass, to include intelligent and adaptive web-based systems that learn instructor and learner behavior to adjust accordingly, to enrich the educational experience.

The application of AI algorithms and systems in education are gaining increased interest year by year. Fig. 1 shows the rising number of papers published in the topics “AI” and “Education” from Web of Science and Google scholar since 2010. Note that the papers published in 2015–2019 accounted for a large proportion, i.e., 70% of all

the papers indexed. As education evolves, researchers are trying to apply advanced AI techniques, i.e., deep learning, data mining, to deal with complex issues and customize teaching method for individual student.

❖ **Integrating Technology and AI in Teacher Training**

The integration of technology and artificial intelligence (AI) in teacher training has revolutionized the way educators prepare for modern classrooms. With the increasing complexity of education systems, evolving student needs, and the rapid advancement of digital tools, training teachers using AI-powered and technology-driven methods is becoming essential. These tools not only enhance traditional teacher training programs but also provide personalized, data-driven insights that help educators refine their skills and adapt to diverse learning environments.

AI in Teacher Training

AI is transforming teacher training by providing data-driven insights, automating administrative tasks, and personalizing learning experiences. Some of the key applications of AI in teacher education include:

- **Personalized Training Programs:** AI-powered platforms analyze teachers' strengths and weaknesses to recommend tailored training modules, ensuring they focus on areas that need improvement.
- **Automated Feedback and Assessment:** AI-driven tools can assess lesson plans, teaching styles, and classroom interactions, offering constructive feedback to help teachers refine their instructional methods.
- **AI Chatbots and Virtual Assistants:** These tools provide instant support, answering teachers' queries about lesson planning, student engagement, and subject-specific teaching strategies.
- **Data-Driven Decision Making:** AI analyzes student performance and classroom dynamics to guide teachers in adopting the most effective teaching strategies for different learning styles.

Benefits of Integrating Technology and AI in Teacher Training

The integration of technology and AI in teacher training offers numerous benefits, including:

- **Enhanced Teaching Effectiveness:** With access to real-time feedback, personalized training, and innovative teaching tools, educators can improve their instructional strategies.

- **Flexibility and Accessibility:** Online platforms and AI-driven training programs allow teachers to learn at their own pace and convenience, reducing the constraints of traditional training methods.
- **Improved Classroom Management:** AI simulations and virtual training environments help teachers develop better classroom management skills before entering a real classroom.
- **Better Student Engagement:** Teachers trained with AI-powered tools are better equipped to use interactive and adaptive teaching methods, leading to increased student participation and understanding.

Challenges in integrating artificial intelligence (AI) in teacher training

Integrating artificial intelligence (AI) into pre-service teacher education also presents several challenges that must be addressed to maximize its effectiveness and ensure equitable outcomes. Here are some key challenges:

- **Access and Equity:** Not all pre-service teachers may have equal access to AI-powered tools and resources due to disparities in technology infrastructure, internet connectivity, and financial resources. Ensuring equitable access to AI technologies is essential to prevent exacerbating existing inequalities in education.
- **Training and Support:** Pre-service teachers and educators may lack the necessary training and support to effectively use AI technologies in teaching and learning. Providing comprehensive professional development programs and ongoing support is crucial to build educators' capacity and confidence in utilizing AI tools.
- **Ethical Considerations:** AI technologies raise ethical concerns related to data privacy, security, transparency, and algorithmic bias. Pre-service teachers and educators need to be aware of these ethical implications and engage in critical discussions about responsible AI use in education.
- **Pedagogical Integration:** Integrating AI into pre-service teacher education requires careful consideration of its pedagogical implications and alignment with educational goals and standards. Pre-service teachers need guidance on how to effectively integrate AI technologies into their teaching practices to enhance learning outcomes.
- **Overreliance on Technology:** There is a risk of overreliance on AI technologies, leading to a reduction in human interaction and critical thinking

skills. Pre-service teachers must strike a balance between leveraging AI tools and maintaining meaningful teacher-student relationships and fostering students' higher-order thinking skills.

- **Quality of AI Algorithms and Data:** The quality and accuracy of AI algorithms depend on the quality and diversity of the data used to train them. Biases in AI algorithms can perpetuate inequalities and reinforce stereotypes, particularly in educational settings. Pre-service teachers need to critically evaluate AI-generated recommendations and outputs to mitigate potential biases.
- **Cost and Sustainability:** Implementing AI technologies in pre-service teacher education programs requires significant financial investment in infrastructure, software licenses, and professional development. Ensuring the long-term sustainability of AI initiatives may be challenging for institutions with limited resources.
- **Resistance to Change:** Resistance to change from pre-service teachers, educators, and educational institutions can impede the adoption of AI in teacher education. Addressing concerns, fostering a culture of innovation, and highlighting the benefits of AI are essential to overcoming resistance and promoting widespread adoption.

Challenges and Considerations

While technology and AI offer promising solutions for teacher training, there are challenges to consider:

- **Digital Literacy:** Not all educators are tech-savvy, requiring additional training to effectively use AI-powered tools.
- **Cost and Accessibility:** Advanced AI-driven training programs may be expensive, limiting access for teachers in low-resource settings.
- **Ethical Concerns:** The use of AI in teacher evaluation and training must be transparent, ensuring that educators' privacy and autonomy are respected.
- **The Ethics of AI in EdTech:** Ensuring Student Success in a Digital Age

Challenges and Concerns Around AI in Education

While AI in education offers numerous advantages, responsible use of AI means being aware of potential concerns.

1. **Privacy:** Even following cybersecurity best practices doesn't guarantee full protection from a cyberattack. Companies producing AI products must meet

industry security standards to ensure the appropriate use of data and content processed by AI technology.

2. **Equity:** While AI can bring instructional content to anywhere in the world, a user needs internet access to engage with the tool. This puts an additional burden on communities that are already under-resourced—and potentially will leave them even farther behind.
3. **Teaching roles:** While AI will in no way replace human teachers, it will change the ways in which they plan lessons, review student data, and deliver instruction.
4. **Ethics:** The ethical use of AI, alongside the possibility of algorithmic bias, is a concern. This bias occurs when an algorithm produces results that are systematically prejudiced due to false assumptions in the machine learning process. Fortunately, this bias is expected to decrease over time as AI tools are used more broadly.
5. **AI Myths and Misconceptions:** By fostering informed dialogue, emphasizing ethical use, and prioritizing security, we can use AI as a valuable in shaping innovative and inclusive learning experiences for all students.

The Role of Technology in Teacher Training

Technology has long played a significant role in education, but its integration into teacher training programs has accelerated in recent years. Digital platforms, interactive simulations, and online courses provide teachers with flexible learning opportunities that suit their schedules and learning styles. Some of the key technological innovations in teacher training include:

Role of teacher educators

The role of teacher educators is crucial in integrating artificial intelligence (AI) into pre-service teacher education. Teacher educators play a multifaceted role in preparing future educators to effectively leverage AI technologies in their teaching practice. Here are some key roles:

Curriculum Development: Teacher educators are responsible for designing and updating pre-service teacher education curricula to incorporate AI concepts, tools, and applications. They identify relevant content areas, learning objectives, and pedagogical approaches that align with the integration of AI in teaching and learning.

Instruction and Facilitation: Teacher educators deliver instructional sessions, workshops, and training modules to pre-service teachers on AI-related topics. They

provide guidance on how to use AI tools effectively, facilitate hands-on learning experiences, and foster critical thinking and reflection about the ethical and pedagogical implications of AI in education.

Professional Development: Teacher educators offer professional development opportunities for in-service teachers to enhance their knowledge and skills in AI integration. They organize seminars, conferences, and ongoing training programs to support teachers' continuous learning and growth in using AI technologies to improve teaching effectiveness and student learning outcomes.

Modeling Best Practices: Teacher educators serve as role models by demonstrating effective use of AI technologies in their own teaching and research. They showcase innovative pedagogical approaches,

Research and Scholarship: Teacher educators engage in research and scholarship to advance knowledge and understanding of AI in education. They conduct empirical studies, evaluate AI applications in teaching and learning contexts, and contribute to the development of evidence-based practices and guidelines for AI integration in pre-service teacher education.

Collaboration and Partnerships: Teacher educators collaborate with industry partners, technology developers, and other stakeholders to stay abreast of the latest AI trends and innovations. They foster partnerships with schools, universities, and professional organizations to promote interdisciplinary collaboration and share best practices in AI integration.

Advocacy and Policy Development: Teacher educators advocate for policies and initiatives that support the integration of AI into pre-service teacher education. They participate in policy discussions, advisory committees, and advocacy campaigns to raise awareness about the importance of AI literacy for educators and advocate for resources and support to facilitate AI integration in teacher preparation programs.

Challenges in integrating artificial intelligence (AI) into pre-service teacher education

Integrating artificial intelligence (AI) into pre-service teacher education also presents several challenges that must be addressed to maximize its effectiveness and ensure equitable outcomes. Here are some key challenges:

1. Access and Equity: Not all pre-service teachers may have equal access to AI-powered tools and resources due to disparities in technology infrastructure, internet

connectivity, and financial resources. Ensuring equitable access to AI technologies is essential to prevent exacerbating existing inequalities in education.

2. Training and Support: Pre-service teachers and educators may lack the necessary training and support to effectively use AI technologies in teaching and learning. Providing comprehensive professional development programs and ongoing support is crucial to build educators' capacity and confidence in utilizing AI tools.

3. Ethical Considerations: AI technologies raise ethical concerns related to data privacy, security, transparency, and algorithmic bias. Pre-service teachers and educators need to be aware of these ethical implications and engage in critical discussions about responsible AI use in education.

4. Pedagogical Integration: Integrating AI into pre-service teacher education requires careful consideration of its pedagogical implications and alignment with educational goals and standards. Pre-service teachers need guidance on how to effectively integrate AI technologies into their teaching practices to enhance learning outcomes.

5. Overreliance on Technology: There is a risk of overreliance on AI technologies, leading to a reduction in human interaction and critical thinking skills. Pre-service teachers must strike a balance between leveraging AI tools and maintaining meaningful teacher-student relationships and fostering students' higher-order thinking skills.

6. Quality of AI Algorithms and Data: The quality and accuracy of AI algorithms depend on the quality and diversity of the data used to train them. Biases in AI algorithms can perpetuate inequalities and reinforce stereotypes, particularly in educational settings. Pre-service teachers need to critically evaluate AI-generated recommendations and outputs to mitigate potential biases.

7. Cost and Sustainability: Implementing AI technologies in pre-service teacher education programs requires significant financial investment in infrastructure, software licenses, and professional development. Ensuring the long-term sustainability of AI initiatives may be challenging for institutions with limited resources.

8. Resistance to Change: Resistance to change from pre-service teachers, educators, and educational institutions can impede the adoption of AI in teacher education. Addressing concerns, fostering a culture of innovation, and highlighting the benefits of AI are essential to overcoming resistance and promoting widespread adoption.

The Role of Technology in Modern Teacher Training

Evolution of Teacher Training

Historically, teacher training has focused on standardized curricula delivered through workshops, seminars, and classroom observations. These traditional methods, though effective to some extent, often fail to cater to the diverse learning needs of educators. With the integration of technology, modern teacher training programs now leverage digital tools, online platforms, and AI-driven insights to provide a more personalized and efficient learning experience.

Digital Learning Platforms

- **Massive Open Online Courses (MOOCs):** MOOCs, such as those offered by Coursera, edX, and Udemy, provide accessible, expert-led teacher training programs. These courses offer flexibility, allowing educators to learn at their own pace while accessing global best practices in teaching. Platforms such as Coursera, Udemy, and EdX offer teacher training courses that educators can access from anywhere, allowing them to upgrade their skills at their own pace.
- **Learning Management Systems (LMS):** LMS platforms like Moodle, Google Classroom, and Blackboard facilitate structured learning experiences. Teachers can access training materials, participate in discussions, submit assignments, and receive feedback, creating an interactive and collaborative training environment.
- **Gamification and Microlearning:** Gamification integrates game-like elements into teacher training, making learning engaging and effective. Microlearning, through short and interactive lessons, enhances retention and application of knowledge.
- **Immersive Technologies (VR & AR)**
Virtual Reality (VR): VR provides simulated classroom environments where teachers can practice their teaching skills in real-time. These simulations include student interactions, behavioral challenges, and lesson delivery, offering experiential learning without real-world consequences. These technologies simulate real classroom environments, allowing teachers to practice classroom management, lesson delivery, and student engagement techniques in a risk-free setting.

Augmented Reality (AR):AR enhances lesson planning by overlaying digital content onto real-world teaching scenarios. This allows teachers to visualize complex concepts, improving instructional design and delivery.

❖ **WHY EDUCATORS NEED TO UNDERSTAND AI TOOLS**

Our roles as educators have continued to change over the years. With technology comes a bit of hesitancy, especially with something as powerful as AI. In our schools, we have to provide opportunities for students to learn about changing technology because of the impact it may have on their future. Not only can AI tools enhance creativity and productivity, but also, they can provide educators with valuable insights into student learning and assist with some of the time-consuming tasks that educators have.

Even with all of the promises of AI, it is important that we take time to talk about artificial intelligence in our classrooms. Not only do we teach the content, but we serve as mentors, facilitators of learning and co-learners with our students, especially as we embrace these emerging powerful technologies. It's important that we help our students learn about the benefits of them and also show how to use these tools properly, responsibly, and ethically.

HOW AI CAN IMPROVE A TEACHER'S JOB

Personalized learning: Educators can provide tailored learning experiences based on AI-driven analytics that provide valuable insights into student performance and learning trends. Using this data, AI can instantly adapt student learning materials. Teachers can then use this information to provide personalized learning experiences, adapting to each student's strengths, weaknesses, and learning pace.

Productivity and efficiency: Greater efficiency comes with AI as well. Educators are responsible for a variety of clerical tasks, such as communicating with students and their families, grading assessments, and providing feedback. Educators may find they spend more time on these clerical tasks rather than on teaching and working directly with students. The right AI tools can help to automate or streamline these tasks, which allows teachers to have additional time with their students.

Creating and supplementing content: Through AI-powered platforms, teachers can curate a range of educational resources. With generative AI in particular, teachers are able to create lessons, activities, assessments, prompts for discussion, and presentations simply by providing a short prompt with keywords.

EDUCATION TOOLS THAT WORK

Here are seven AI-powered tools that will help teachers with personalized learning that enables them to become more efficient and save time that can then be spent with students. I have used each of these for my own personal writing and creating of presentations, and the amount of time they save by generating the slides alone helps me to focus more closely on the content. I also appreciate that the tools offer translation options and a variety of templates and other resources that are commonly used by educators.

1. Audio Pen: This tool using voice-to-text to write blogs, books, emails, and lesson plans. This is an AI-powered web app that you can use on your computer or phone. The app takes your words and enhances them as it generates the text, which you can edit as needed.

2. Canva Magic Write: Canva now offers an AI text-to-image generator called Magic Write, which can inspire creativity in writing. It provides ideas, helps with brainstorming, and supports lesson planning, making it a useful tool for educators for creating a presentation or other graphic for classroom use. Magic Write can assist with many writing tasks that educators may have by analyzing the word prompts and then helping with brainstorming, creating an outline, writing lesson plans, or generating a visually engaging presentation in far less time.

3. Curipod: This website enables teachers to create interactive lessons in minutes using AI. Students can explore various topics, and the AI functionality helps generate customized lessons tailored to their learning needs. Teachers simply type in a topic, and a ready-to-run lesson is generated with text, images, and activities such as polls, open-ended responses, word clouds, and more. There are even activities to build in that focus on SEL check-ins.

4. Eduaide. Ai: This is an AI-assisted lesson-development tool that provides educators with more than 100 resource types to choose from to create high-quality instructional materials. It offers the ability to translate the generated content into more than 15 languages instantly. Educators can generate a syllabus, create discussion prompts, use the “teaching assistant” for help with creating individualized education program plans, write emails, or even compile a list of accommodations for students. Eduaide.AI has a content generator, teaching assistant, feedback bot, free-form chat, and assessment builder.

5. OpenAI: The recently released Teaching with AI guide for teachers was created to help educators use ChatGPT in their classroom. The guide comes with several suggested prompts and includes explanations that clarify exactly how ChatGPT works and what its limitations are, and it provides reminders of the importance of verifying information and checking for bias. With ChatGPT, which is a paid version, there is greater accuracy and reliability of information than with the original version.

6. Quizizz: With Quizizz, teachers can design quizzes that will create a personalized learning path based on each student's responses. Teachers can also create lessons with Quizizz, which now has an AI enhancement that can adjust question difficulty, check grammar, and redesign questions to reflect real-world scenarios, with more features on the way.

7. Slides go: This tool provides access to free templates via Google Slides and now has the AI Presentation Maker. With this new functionality, presentations can be created within minutes. Simply choose a topic; select a tone such as casual, creative, or professional; make changes; and download your presentation. A time-saver for sure!

Creating and sharing these resources with our students leads to rich conversations about the benefits of AI and proper use of this technology for creating and learning. There are many more tools available for teachers to explore that can help with each of the key areas that I mentioned. Most important is selecting a tool to start with and reflecting on how it impacted your practice.

AI-Driven Innovations in Teacher Training: AI is transforming teacher training by offering tools for personalized learning, automated grading, and data-driven insights, allowing for more efficient and effective training programs.

Here's a deeper dive into the AI-driven innovations in teacher training:

1. Personalized Learning & Adaptive Training:

- **AI-powered platforms:** Can analyze teacher performance data and learning outcomes to identify strengths and weaknesses, enabling tailored training modules and resources.
- **Adaptive Learning Systems:** These systems adjust the difficulty and content of training materials based on the individual teacher's progress and learning style, leading to more effective knowledge acquisition.
- **Personalized Learning Paths:** AI can create customized learning paths for each teacher, focusing on specific skills and areas for improvement.

2. Automated Grading & Feedback:

- **AI-powered grading tools:** Can automate the grading of certain types of assignments, freeing up teachers' time for more personalized feedback and instruction.
- **Real-time feedback:** AI can provide teachers with immediate feedback on their teaching practices, allowing for continuous improvement and reflection.
- **Data-driven insights:** AI can analyze data from training programs to identify trends and patterns, helping to improve the effectiveness of future training initiatives.

3. Enhanced Accessibility & Inclusivity:

- **Language translation tools:** AI can facilitate language translation, making training materials and resources accessible to teachers from diverse linguistic backgrounds.
- **Assistive technologies:** AI can power assistive technologies that support teachers with disabilities, ensuring inclusive access to training and professional development.
- **Virtual and Augmented Reality:** AI can be used to create immersive and interactive learning experiences, making training more engaging and effective.

4. Streamlined Content Creation & Delivery:

- **AI-powered content generation:** AI can assist in creating training materials, lesson plans, and other resources, saving teachers time and effort.
- **Automated lesson planning:** AI can help teachers plan lessons and activities, ensuring that they are aligned with learning objectives and standards.
- **Virtual classrooms and AI-driven collaboration tools:** AI can facilitate collaborative learning environments, where teachers can engage in group activities and projects across geographical boundaries.

5. Data Analysis & Reporting:

- **AI-driven analytics:** AI can analyze data from training programs to identify trends and patterns, helping to improve the effectiveness of future training initiatives.
- **Predictive analytics:** AI can predict potential skill shortages and identify areas where teachers may need additional support.

- **Automated reporting:** AI can automate the process of generating reports on training outcomes, making it easier for educators to track progress and assess effectiveness

Personalized Learning & AI Tutors

AI analyzes learning patterns and adapts training programs based on individual strengths and weaknesses. AI tutors offer personalized support, ensuring that educators receive relevant content tailored to their needs.

Automated Grading Systems

AI-driven grading tools, such as Turnitin and Grammarly, provide instant feedback on written work, improving efficiency and consistency in assessment.

AI-Driven Classroom Analytics

AI tools analyze classroom interactions, student engagement levels, and teacher effectiveness, offering insights to improve instructional strategies.

AI-Based Virtual Mentors and Coaching

AI chatbots and virtual assistants provide 24/7 support, answering queries and offering personalized teaching recommendations. Real-time coaching systems help educators refine their instructional techniques through AI-driven feedback.

Benefits of AI and Technology in Teacher Training

- **Enhanced Professional Development:** Continuous learning through AI-driven insights and digital resources keeps teachers updated with evolving pedagogical trends.
- **Time Efficiency:** Automation reduces administrative workload, allowing educators to focus on instruction and student engagement.
- **Data-Driven Decision Making:** AI-powered analytics enable teachers to make informed pedagogical choices based on real-time data.

Challenges and Considerations

- **Technological Barriers:** Many regions lack the necessary infrastructure to implement AI and technology-driven training programs effectively.
- **Ethical and Privacy Concerns:** Data security risks associated with AI-driven analytics must be addressed to protect educators' and students' personal information.
- **Resistance to Change:** Some educators may be hesitant to adopt AI-based training methods due to unfamiliarity or concerns about technology replacing human interactions in education.

Future Directions and Recommendations

- **Policy and Infrastructure Development:** Governments and educational institutions must invest in digital infrastructure to ensure equitable access to AI-powered training tools.
- **AI Ethics and Teacher Autonomy:** Establishing ethical guidelines for AI use in education will ensure that technology supports rather than replaces teachers.
- **Continuous Research and Innovation:** Ongoing research is necessary to refine AI-driven teacher training models, making them more adaptive, ethical, and effective.

Conclusion

The integration of AI and technology in teacher training is revolutionizing professional development in education. These advancements enable personalized learning, real-time feedback, immersive simulations, and automated assessments, enhancing the quality of teacher training programs. However, challenges such as technological barriers, ethical considerations, and resistance to change must be addressed to maximize the potential of AI-driven teacher training. By embracing AI and digital tools, the education sector can equip teachers with the skills needed to navigate the evolving landscape of modern classrooms, ensuring better learning outcomes for future generations.

Integrating technology and AI in teacher training is a crucial step toward preparing educators for the demands of 21st-century classrooms. By leveraging digital tools, AI-driven analytics, and innovative learning platforms, teachers can enhance their skills, improve student engagement, and create more effective learning environments. However, to maximize the benefits of these advancements, it is essential to address challenges such as accessibility, cost, and ethical considerations. As technology continues to evolve, so must teacher training programs, ensuring that educators remain at the forefront of educational innovation.

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Competencies for 21ST Century Teachers

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Abstract

In the 21st century, the teacher plays the role of manager in the teaching-learning. Teachers are not just knowledge providers but also facilitators of learning, mentors, and role models. Their competencies are essential to prepare students for the complexities of the modern world, ensuring they are equipped with the skills, knowledge, and attitudes needed to succeed in life and work. This article expresses the competencies of the 21st-century teachers. A teacher's competency includes a wide range of skills, including pedagogical knowledge, subject matter expertise, the ability to use technology effectively, critical thinking, problem-solving, leadership and management skills, communication skills, and a commitment to lifelong learning.

Keywords: Teacher, Competencies, Education and 21st Century

Introduction

Because of the dynamic nature of our society, the educational landscape is changing quickly. Society aims to sustain in the dynamic digital modern world, and we have to equip our young generation with such skills so that they will sustain wherever they go. It depends on the dynamic role of the 21st-century teachers. Teachers have a significant impact on our children's futures and, consequently, the future of our country. Teachers were the most esteemed members of society in India because of their noble duty. The goals of education will be character development, cognitive growth, and the creation of holistic, well-rounded people with the crucial 21st-century skills. (NEP -2020). The teacher is at the centre of the significant changes being made to India's educational system, according to the National Education Policy 2020 (NEP - 2020). Every citizen's life is impacted by the ongoing process of education, in which the teacher is an essential part. And they have to possess such types of competencies

and skills so that they would be able to produce the skills, competencies, and abilities among the young generation so that they can transform and sustain themselves in the ever-changing society.

Competency

The capacity to perform a task effectively or successfully is known as competency. (**The Oxford Dictionary**). Competence is the collection of observable human traits (knowledge, skills, abilities, and other traits) that allow for consistent, high-level work performance with little difficulty. (**Source: Wikipedia**). A competency is more than simply knowledge and skills; it's the capacity to use and mobilize psychological resources in a given situation to meet complex demands. A teacher's quest for excellence depends on their level of competency. Teachers need to have a broad variety of competencies to handle the complex challenges of today's world.

Competencies for 21st Century Teachers

A teacher's competency for 21st century includes a wide range of skills, including pedagogical knowledge, subject matter expertise, the ability to use technology effectively, critical thinking, Problem-Solving, leadership and management skills, communication skills, and a commitment to lifelong learning.

Pedagogical Competency

It pertains to knowledge of typical teaching techniques, classroom learning taxonomies, and instructional materials. Adolescent and adult behaviours must be studied by teachers to comprehend their target group and become proficient in evaluating the needs, abilities, attitudes, beliefs, and psychological characteristics of young people to create instructional materials. Teachers must have pedagogical competences in the twenty-first century. This skill is necessary to successfully present the content to students and include them in meaningful learning experiences. (**TPACK frame work**)

Subject knowledge

In addition to having pedagogical competency, teachers should be subject-matter experts who have a comprehensive understanding of the subject matter. Since learning objectives are based on content, he or she cannot prepare them without understanding

the subject matter. Without topic knowledge, he or she is unable to offer guidance the students.

Critical Thinking

In contemporary education, problem-solving, creativity, and critical thinking are considered significantly more than rote memorization. The process of evaluating existing data, facts, and observations to draw wise conclusions or make well-informed decisions is known as critical thinking. It entails identifying fundamental presumptions, offering arguments in support of concepts and acts, analysing these arguments from various perspectives, and determining their plausibility and possible repercussions. Forming a judgment by applying logical, sceptical, and objective analysis and evaluation is the aim of critical thinking. Critical thinking skills are the skill that helps a person analyze, interpret, and evaluate what we do, say, read, or hear. Which makes the teacher a better decision maker and judge accordingly. (Wikipedia)

Leadership and Management skills

Leadership and management abilities are among the 21st century teacher's most crucial competencies. Teachers plan, organize, oversee, and assess the teaching and learning process as educational managers.

We are well aware of the role that teachers play in elementary, secondary, and higher education. It provides each institution more autonomy and decision-making power, with teachers serving as managers and leaders. These abilities will support the teacher in motivating pupils, fostering an inclusive environment, and establishing specific learning objectives. For teachers to succeed in the classroom and advance their careers, these abilities are essential (NPST guidelines 2023)

Problem Solving Skills

Meeting the needs of their students, managing the classroom, using technology, and other challenges are just a few of the challenges that educators encounter in the teaching and learning arenas. The ability to solve problems makes teachers more capable of handling the various challenges they face. Both in the teaching and learning process and in our personal lives, problem-solving abilities enable us to

handle difficulties in a productive manner. Unresolved major issues can lead to mental and physical stress.

Lifelong Learning

Embracing the practice of lifelong learning is crucial for teachers in the twenty-first century. Because our society is dynamic and its demands are continually changing, the knowledge and skills we gain will not always be valuable. Competent teachers can inspire curiosity and self-directed learning in their students. The National Education Policy (NEP-2020) made further recommendations for teachers' ongoing professional development. Teachers must constantly refresh their knowledge and abilities to remain effective and relevant (NEP-2020).

Assessment Strategy

The process of assessment determines a learner's readiness, learning challenges, and ongoing feedback. An essential skill for teachers in the twenty-first century is knowledge of various assessment methods and resources. Students are evaluated using techniques like questioning, classroom observation, asking pupils open-ended questions during the teaching-learning process, peer group discussion, problem solving, testing skills, creativity and notebook writing (end-of-chapter questions) etc.

Effective Communication

Teachers and students exchange information, ideas, and ways of thinking through the process of communication. It encompasses body language, writing, and speaking. A teacher in the twenty-first century should be able to communicate effectively. It covers feedback-giving, verbal and nonverbal communication techniques, and active listening. Students' performance should be discussed by teachers with parents, guardians, and students. Provides students with detailed qualitative feedback when reviewing their assignments or answering their questions. Talks with parents and guardians about their children's performance, primarily about academics and involvement in class, during school-sponsored Parents Teacher Association's meetings.

Digital Competency

India is a global leader in cutting-edge disciplines including space exploration and information and communication technologies. The Digital India Campaign is helping to change the entire nation into a technologically empowered knowledge economy and society.

Digital technologies have revolutionized the process of creating, sharing, and access to knowledge and information. Due to the COVID-19 pandemic's massive growth in digital knowledge transmission, digital competencies are necessary for participation in society, especially for career and lifelong learning opportunities. (NEP -2020).

For Teachers in the twenty-first century, digital literacy is one of the most crucial skills. We now live in a digital age, and the educational landscape has changed significantly from an offline to an online one. With their understanding of digital technology, the instructor would use websites and educational apps on mobile devices, laptops, and computers for articles and journals, and create digital contents for the students and use them in the teaching and learning for imparting effectively.

Technological Competency

21st century is marked by rapid technological advancements. A teacher must be proficient in using technology for learning. Teachers need to be proficient in using digital tools, online platforms and educational technologies to enhance learning experience. Technological Competency recognizes the right time and place one should use the best kind and level of technology available for education to optimize student learning. Technology and education at all levels will have a reciprocal relationship as, although education will be crucial to this change, technology will also be crucial to improving educational procedures and results. (TPACK Frame work)

Time Management skills

Time management and teamwork are the most prevalent and crucial skills for teachers in the twenty-first century. Effective time management is essential for both the teaching and learning process. Effective time management increases productivity, enables us to create well-structured lectures, and keeps students interested in the material.

Skills of Addressing Diverse Learning needs

Students from a wide range of socioeconomic, linguistic, and cultural backgrounds are present in modern educational institutions. Teachers must therefore be able to provide unique instruction and establish inclusive learning environments that meet the needs of every student.

Conclusion

Thus, teachers in the twenty-first century need to possess a wide range of competencies, including pedagogical, professional, critical thinking, time management, Skills of Addressing Diverse Learning needs, Technological Competency, assessment strategy, lifelong learning, digital and communicative abilities. In order to prepare children to succeed in a complex, linked world, these qualities are crucial. Improving these competencies requires ongoing professional development as well as the incorporation of technology into instructional strategies. Teachers can effectively prepare students for success in the twenty-first century by creating an atmosphere that values critical thinking, creativity, and teamwork.

Acknowledgement

I would like to express my opinion that in accordance with NEP-2020 Visions, the TPACK framework, and Guideline 2023 for the National Professional Standard for Teachers, I have envisioned the competencies of teachers in the twenty-first century. The way each person visualizes would vary from person to person; it is entirely dependent on their viewpoints and visualization style.

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Abstract

The accelerated evolution of digital technologies has revolutionized the classroom setting, calling for a paradigm shift in teaching methods and pedagogies. The present study explores the need to reconceptualize teaching methods and pedagogies to meet the needs of a digital world, highlighting the importance of technology integration, student-centered instruction and innovative assessment strategies. Through theoretical models and empirical case studies, the study explores how digital resources enable personalized learning, collaborative learning and the development of critical thinking skills. The educator's role is redefined, from being a mere knowledge dispenser to facilitator and co-creator of the learning process. Various challenges, from digital equity concerns, ethical issues and the digital divide are explored, providing solutions to ensure inclusive and equitable education for all learning groups. The study highlights the need for ongoing professional development and institutional support to empower educators in adopting technology-enhanced pedagogies. This article adds to the literature on educational transformation by offering practical recommendations for stakeholders who want to leverage the potential of digital technologies to improve the learning experience. In today's digital world, connectivism pedagogy has been a significant conceptual model explaining the processes of knowledge acquisition and dissemination in networks, particularly through digital media platforms. Connectivism is based on the premise that learning takes place through the establishment of relationships in a network where the process of acquiring new knowledge is more important than existing knowledge; unlike other theories of learning that emphasize cognitive processes engaged by the learner. Digital media platforms have greatly amplified this phenomenon, allowing learners to access, share and collaboratively construct knowledge in real-time within global networks. This study also explores the nexus between connectivism and social media, with emphasis on changes in self-directed and collaborative learning experiences through social media. Social networking sites like Facebook, WhatsApp, LinkedIn, Twitter and YouTube enable the formation of enormous learning networks where learners can interact, exchange resources and get instant feedback from peers and professionals. Through this way, such sites enable two of the most critical pillars of connectivism: promoting varied relationships and tapping collective intelligence to make learners responsive to a fast-changing knowledge environment. However, challenges like information overload, digital divide and data privacy issues are major impediments to the effective integration of social media in connectivist learning. To further optimize social media use in connectivist learning models, this paper critically analyzes such challenges and suggests possible solutions. For the effective use of connectivism in the digital era, the most crucial aspect is that teachers and learners become digitally literate and follow social media ethics. The paper concludes with a discussion of the implications of this learning process to lifelong learning and professional development, highlighting the necessity for educators to adapt to the changing patterns of knowledge acquisition and dissemination in an increasingly interconnected world.

Keywords : Digital Pedagogies, Digital Literacy, Connectivism, Technology-Enhanced Learning, Personalized Learning, Digital Equity, 21st Century Skills.

Introduction

The sheer pace of evolution in education has transformed the lives of people through learning and conversation with information mediated by digital technology. The boundary of learning had been confined within classrooms and passive resources earlier, but today, it is fluid and dynamic that promotes networked and collaborative nature of learning. This transformation brought forth the notion of connectivism, which is a theory of learning centered around the significance of technology, networked individuals and flows of information in outlining the learning process. George Siemens' connectivist theory that took shape in the year 2005 is much different from established learning theories such as constructivism, cognitivism and behaviorism. Based on it, learning not only happens in an individual but also within technology architectures and people networks. For this perspective, learning is framed as the art of creating, maintaining and connecting relationships. Knowledge may be dispersed in the form of networks of relationships. In today's world, being able to associate oneself with knowledge sources and remaining informed has increasingly become important, particularly in the era of quick change and surfeit of information.

In the context of a connectivist learning system, digital media has become an integral part. Social media sites enable content creation and sharing, the development of learning communities and live debate. In particular, through participation on sites like Twitter, Facebook, LinkedIn, YouTube and others, learners are able to enhance their learning experience through access to volumes of knowledge by experts and participation in global debates. Furthermore, these sites enable a more personalized learning process, where the user is able to customize their learning pathways based on interests, needs and goals. However, the incorporation of social media in learning processes comes with some challenges: first, the amount of information easily accessible makes it hard for the learner to examine each source and determine the validity of that source. Second, social media-driven interactions are likely to be too informal in nature, leading to shallow learning as opposed to the development of deep knowledge. Despite these drawbacks, the learning architecture and pedagogical strategy of connectivism actually provide the foundation of the understanding of learning in the context of the digital era; an era where the capacity to connect, share and transform is critical to learning success. To explore how social media is a medium for creating, sharing and applying knowledge, this study explores the connotations of connectivism in an online context and digital context.

Objectives of the Study

1. To reimagining the pedagogies for a digital age.
2. To explore the theoretical roots of connectivism as a pedagogy and learning style.
3. To analyze the Connectivism's view as pedagogy for a digital age.
4. To identify the opportunities and challenges of pedagogies for a digital age.
5. To propose strategies for enhancing pedagogy for a digital age.

Methodology of the Study

The methodology of the this study undergoes a comprehensive literature review of existing literature on this subject to research whether or not digital age based pedagogical practices can foster critical thinking, collaborative learning and self-directed learning among students.

Theoretical Frameworks

Within the rapidly changing field of education, digital pedagogies have emerged as an innovative aspect, transforming teaching and learning approaches. Digital pedagogy is a term for the innovative deployment of digital tools and online sources in an endeavor to enrich education. It consists of a series of methodologies like blended learning, flipped classrooms, adaptive learning technologies and interactive online learning sites. As the pedagogy of education changes course towards an increased technology-focused environment, digital pedagogies become a significant player in making learning more available, personalized and interactive. A key strength of digital pedagogies rests in their ability to provide differentiated learning experiences. As opposed to the traditional classroom, where an even approach is often the case, digital tools provide teachers the flexibility to re-design content to fit the distinct requirements of different learners. Adaptive learning technologies that deploy artificial intelligence analyze students' performances and readjust instructional resources according to demand, thus optimizing learning. The extent of individualization helps narrow gaps in learning and fosters deeper understanding of content. Beyond that, digital pedagogies allow for students to engage actively with learning content. Interactive material, multimedia objects and gamefied educational activities make learning more engaging and inspiring. Through the integration of online forums of discussion, online virtual simulations and collaborative digital projects, learning nurtures problem-solving skills, critical thinking and creativity. The approach, while accommodating difference, also readies

students to adapt to the digital economy as their technological acumen is empowered. Therefore digital pedagogies enhance inclusivity and access to educational opportunities. Online sites and digital assets negate geographical challenges, making learning possible for learners independent of place. This becomes especially beneficial to students located within rural or distant regions who experience limited access to high-quality opportunities to learn. Further, digital tools can also be scripted to assist disabled learners with the aid of assistive technologies such as screen readers, speech-to-text software and captioned audio and video material. However, while there are numerous benefits, the implementation of digital pedagogies is also associated with a few issues. The most predominant issue is the digital divide since not every learner has access to stable internet connection or digital devices. It is also essential that instructors have the necessary digital literacy skills in order to use technology in the process of instruction in an efficient way. Institutional assistance and teacher development are instrumental in overcoming such problems and enhancing effective use of digital pedagogies.

Digital Literacy is the ability to effectively search for, analyze, create and share information with digital technologies. It incorporates a wide range of skills, such as the use of the internet, understanding digital tools, online security and critically analyzing digital information. In the 21st century, digital literacy has become essential for education, employment and civic life since it equips individuals with the skills to utilize the digital world effectively and responsibly. As artificial intelligence and online learning platforms increasingly find entry into learning spaces, digital literacy also includes ethical concerns, data privacy and the ability to learn evolving technologies. Technology-Enhanced Learning (TEL) is the use of digital tools, resources and technologies to facilitate and enhance teaching-learning. It includes a range of approaches, such as online learning platforms, AI-based adaptive learning, virtual and augmented reality, gamification and adaptive learning systems. TEL increases student engagement, accessibility and collaboration, allowing learners to interact with content in creative ways. Additionally, it enables flexible learning environments, such as blended and flipped classrooms, that enhance self-directed learning and skill development. With the advent of AI and data analytics, TEL is playing an important role in optimizing learning experiences and outcomes in modern learning environments. Personalized Learning is a pedagogical approach that tailors instruction, content, and pace to meet the unique needs, preferences, and interests of

individual learners. This approach leverages technology, adaptive learning systems and data-driven insights to provide personalized learning experiences. At the core of personalized learning are student-centered instruction, flexible learning pathways, competency-based progression and immediate feedback. This approach increases student engagement, improves learning outcomes and fosters self-directed learning by allowing students to learn at their own pace. The convergence of artificial intelligence (AI) and digital media has maximized the efficacy of personalized learning in addressing diverse learning needs. Digital equity is understood to be the delivery of equal and inclusive access to digital technologies, resources, and opportunities so that all individuals regardless of socioeconomic status, place, disabilities or other barriers can effectively participate in the digital world. This includes access to quality internet connections, digital devices, digital literacy education and support structures. Digital equity significantly contributes to bridging the digital divide, maximizing educational opportunity, workforce development and facilitating social inclusion. As technology assumes an increasing importance in education and working life, the achievement of digital equity is vital in providing equal opportunities to all members of an increasingly dynamic digital society.

21st Century Skills are key abilities that prepare individuals to succeed in a more intricate, technology-integrated and globalized environment. They surpass the conventional understanding of academic competencies and target critical thinking, creativity, collaboration and communication; commonly called the “4Cs” of learning and innovation. Along with these core skills, digital literacy is very important, ensuring that people are able to navigate, assess and make use of information efficiently in a digital world. With the fast pace in artificial intelligence, automation and big data, proficiency in information literacy, media literacy and ICT skills is now imperative. In addition, life and career skills like adaptability, leadership, problem-solving and social awareness are essential in building resilience and helping individuals make meaningful contributions to society. These skills not only equip learners for the workplace but also enable them to be lifelong learners, able to adjust to new challenges and innovations. Education systems across the globe are revamping their curriculum to incorporate 21st-century skills through experience-based learning, project-based education and multidisciplinary methodology. In the educational context, personalized learning, technology-enhanced learning and inquiry-based methodologies are being promoted to develop these critical skills. Through digital

equity and access to quality education for everyone, societies can close the digital divide and foster inclusive growth. With the world continuing to change, 21st-century skills remain at the forefront in terms of developing future generations towards personal and professional success.

Reimagining Pedagogies for a Digital Age

George Siemens initially proposed connectivism in 2005. It is a learning theory appropriate for the digital era. According to this idea, learning is primarily controlled by an individual's capacity to traverse and establish connections within social and technological networks. Knowledge is located within these networks. Such a perspective contrasts with the more individualistic processes of behaviorism, cognitivism and constructivism. Connectivism views the learning process as a network formation both internally-neural networks-and externally in social and technological networks. Siemens (2005) supports this when he says, "Learning is the process of creating connections and developing a network" (p. 5). The theory emphasises that learning is the ability to create and navigate these networks, and that information is widely distributed within the network of connections. Connectivism maintains that knowledge is dispersed throughout the network of connections, in contrast to other theories that locate knowledge in an individual. Downes explains further that "knowledge is distributed across a network of connections and learning consists of the ability to construct and traverse those networks" (p. 234). Knowledge, therefore, does not remain an internal cognitive process but also involves an external process of interaction with various information sources.

Connectivism creates consideration for the rapidly changing nature of information in today's digital age. As Siemens (2005) suggests, "the capacity to know more is more critical than what is currently known" (p. 7). This suggests one needs to stay connected to what is new. The ability to make decisions is considered a significant learning process in connectivism. As Siemens said, "Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality" Siemen 2005, p. 6. It means that a learner is always necessitated to assess every information that comes across and he decides whether it is relevant or not. Another very different approach of connectivism is an understanding of a role that nonhuman appliances-in other words, technologies and artificial intelligence-play as companions in learning. According to Siemens, learning may also be literally outside of the individual, in "non-human appliances" (p. 6).

Alam, M. A. (2023) contended that the pedagogy of connectivism is a new pedagogy in teaching and learning in the digital era. The central focus of the pedagogy is networks, connections and integration of new information and ideas into the already established knowledge structure. Theoretically, the pedagogy has foundation for connectivism; several other views are attracted in such as constructivism, social constructivism and chaos theory. The findings showed that connectivism provides a new paradigm for learning founded on the precept of knowing as being distributed amongst nets of people, technologies and organisations.

Alam, M. A. (2024) gives more compelling argument in his paper for use of this new pedagogy is that although this new pedagogy, connectivism, is easily facilitated by any number of digital tools and online platforms, it can certainly contribute significantly to improving learning outcomes through the more effective provision of varied learning opportunities and autonomy to learn in whatever pattern best suits them. The research study identifies that it stresses learner independence and active interaction within the learning networks that includes boundless knowledge development.

Connectivism's View as Pedagogies for a Digital Age

The connectivist hypothesis, in accordance with which social media is integral to learning, presents it as a powerful tool for creating, sharing, and linking information between and within different networks. By making it possible for people to engage in interaction and collaboration in real time, social media enhances the knowledge distributive character inherent in connectivism. The following presents an overview of how social media aids the connectivist model of learning by alluding to diverse studies. Social networking sites such as Reddit, Facebook, LinkedIn and Twitter offer a platform for students to engage with experts, peers and communities of practice. The above-mentioned websites facilitate the networks intended to serve connectivist learning. In this respect, Greenhow and Lewin (2016) observe that social media allows individuals to construct learning networks that make it possible for them to engage with individuals and access diverse perspectives; a concept that is fundamental to connectivism. Studies have shown that social media platforms enhance collaborative learning and knowledge sharing among students. Selwyn (2023), for instance, illustrates how LinkedIn and Twitter enable informal learning and professional networking where students can be in touch with peers and experts globally.

Digital media enables the distribution of knowledge across nodes that could once more be an individual, a digital content, or a community. The social media knowledge is being thought of in a distributed manner, which again signifies the connectivist philosophy. Learning for a connectivist is to navigate these networks. According to Veletsianos (2011), social media platforms have made it easier for students to access materials on a wide scale, which makes it easier to stay up to date with information and trends in any given sector. Social media give access to diverse resources and materials of learning. Ramey (2024) explored how learners utilized e-resources such as YouTube and Reddit in pursuing diverse learning content. This has generally benefited such learners regardless of the diverse content learned from users-generated content or other interactions within the community.

Digital age enable collaborative learning, where users construct knowledge from collective problem-solving, sharing of resources and debate. This notion that knowledge is co-constructed within networks- is core to connectivism theory. Junco, Heiberger, and Loken's (2011) study argues that use of social media within educational settings enhances collaborative learning, and hence develops more interaction with the subject-two critical ingredients to effective connectivist learning. The dynamic movement of information across social networking sites necessitates that students analyze and make a decision on information exposed to them, including the relevancy and veracity of information. Such analysis is imputed in connectivism, with decision-making taken as one of the most central processes of learning. Indeed, Tess (2013) is of the opinion that social media compels students to think critically about what they are shown, a function that enhances their capacity both to move around within complicated networks and to make correct decisions.

Digital era actually offers the channels for instant interaction and feedback, which would be crucial to ongoing learning and adjustments within the networks. Such immediacy is also central to the connectivist learning process as essentially the process is ongoing, dynamic and from constant interactions with others. According to Manca and Ranieri (2016), social media platforms offer immediate feedback, which may enhance learning since learners may tune up with way better understanding and a sooner approach. The immediacy provided by the context of social media allows for real-time interaction and feedback that improve the learning experience. Alternatively, as documented by Walker and Hsu, learners and teachers utilize social media for feeding into instant feedback, which would allow for faster adjustment in

learning approaches and increase engagement. As wonderful as social media is, with its great multitude of advantages, there are some challenges as well. Chen and Wang (2023), in their study, examined misinformation concerns and the potential distraction associated with these websites. These researches highlight the significance of critical media literacy skills in being able to navigate the vast amount of information on social media. Through curating experiences by students, social media has also facilitated the facilitation of support for self-regulated learning. Johnson's research (2024) uncovered platforms like Pinterest and personal blogs that students visit to collect, rearrange and share resources to help facilitate individualized learning paths followed.

Opportunities and Challenges of Pedagogies for a Digital Age

Digital media as learning platforms for connectivist learning are experiencing various opportunities and challenges. While offering widespread connectivity, collaboration and varied information, social media platforms can improve learning significantly. Such benefits, however, come with respective challenges that are to be met for effective learning to occur. The first is that social media can expose students to a wider range of individuals and groups, leading to students being able to access a diverse range of ideas and knowledge. With diversity improving the learning process, students are given the advantage of numerous perspectives, all of which stimulate critical thinking and enable comprehensive understanding of complex themes. These are enabled by social media to enable interactions in real time, where feedback can be provided immediately and subjects discussed or collaborations undertaken at the same moment. That immediacy, in turn, enables the connectivist notion of ongoing learning through knowledge constantly changing in an ongoing process, with learners capable of quickly adjusting to new information. Connectivism with the use of digital media enables learners to develop individualized learning networks, thus enabling learners' specific needs and interests. Learners are able to follow specialists, participate in relevant groups and access resources specifically directed towards their individualistic learning objectives, thus facilitating more personalized learning experiences from their learning processes. Social media are cheap substitutes for traditional education sources. The majority of social media sites make information, courses and tutorials accessible for free, thus enhancing accessibility to education for more individuals by virtue of geographical or economic limitations that can get in the way of their aspirations to learn. Digital resources embraces the concept of lifelong learning in that it keeps information and networks available at all times. Students can find it simple

enough to remain networked to the areas that engage them even outside formal learning and keep learning, a core doctrine of connectivist learning (Kop & Hill, 2008).

Too much information can be released through social media. It might be extremely difficult for the learners to know the difference between the bad and good sources. These difficulties tend to make it difficult to carry out the process of learning effectively since there is a lot of information to sift and prioritize by the learner in question. All the information being released through social media may not be valid or even reliable. The fact that social media platforms are unregulated and this is coupled with the laissez-faire platform can result in the dissemination of misinformation and complicate learning outcomes. Therefore, students will need to become strongly critically thinking when it comes to deciding whether or not information is valid. However, even as such potential is present for social media to improve educational processes, inequality exists in all students regarding access to computers and the internet. Such so-called 'digital divide' could potentially generate unequal opportunities to learn, particularly among low-income or rural residents. (Greenhow & Lewin, 2016). In general, members who subscribe must give their personal details on social media; hence, privacy and data safety issues are concerns. Students will be hesitant to participate full-time in learning through social media due to fear of data leakage or improper use of their details. Social media's inherent nature is to be extremely engaging, thereby leading to distraction and lack of concentration in activities by students. The incessant notifications, advertisements, and unnecessary course material will detract from the learning process and the students will struggle to interact with the content.

Strategies to Improve Pedagogies for a Digital Age

Teachers, schools and students will gain the most from connectivism education in the digital media age if certain strategies are followed that would optimize the capabilities of digital media while addressing its limitations. Develop the skill of digital literacy since there is a lot of information on the websites, students should be able to acquire such digital literacy that will assist them in separating what is credible from what is not. To this end provide training in the skills of accessing online information for credibility, biases and how to use the digital platforms responsibly. Teachers can incorporate elements of digital literacy in the curriculum, which would include critical thinking, verification and proper ethics in using the

internet. Promote networked learning and collaboration to function on the very premise that learning must take place in networks and through collaboration and this inherently social media will be capable of fulfilling. Encourage students to start and engage actively in online communities, discussion forums or collaborative projects through social media. Using this technology, teachers can now create assignments that require students to work collaboratively through digital media with other professionals or peers and build a learning community outside the classroom walls (Veletsianos, 2011).

Give explicit expectations and standards to the learners since social media is so full of distractions that it will be very crucial to make space for some guiding principles that will help learners maintain their concentration and utilize the platforms in an effective manner. Have clear policies and relay them on the use of social media for learning. Teachers must set expectations regarding online conduct, efficient time management and how digital media tools are to be utilized to achieve a particular learning task. Second, developing a code of conduct in online communication will assist in maintaining a respectful and productive learning environment (Manca & Ranieri, 2016).

Leverage analytics of social media to facilitate learner personalised learning that offer a variety of data and analytics through which it is achievable to personalise the learning process according to what individual needs and preferences require. Leverage your own social media platforms where you observe students' trends as against their engagement, usage and consumption of content. The facilitators can then leverage this information in order to provide personalized feedback, identify those specific areas where learners might need support and refer them to resources or networks that best suit their point of interest and learning goals. Practice lifelong learning and keep dynamic engagement alive which allows for continual learning about incidents occurring in all walks of life and keeps the users informed. Get students apply the social media usage concept to lifetime learning: Get students join professional communities, follow industry thought leaders in their area of practice, and continue the conversation. Open up access and enable alumni involvement by making the institution's social media learning communities available for connective continuity and learning long after graduation day. Share and curate high quality content every day, post articles, research papers and study material. Create and share lists of must-read resources or tools on a given topic.

Foster collaborative learning and establish or find discussion forums/groups on social networking platforms to share of interest. Engage in collaborative work, where a team of learners is required to produce content or resolve an issue. Use trending issues and hashtags that observe and build on hashtags utilized within your field of study, keeping them up-to-date with what is being talked about. Take up popular issues with regards to contemporary issues and contemporary. Engage with influencers Follow and engage with top influencers and experts in your field. Watch live sessions, webinars, or Q&A sessions conducted by experts. Peer-to-Peer learning facilitation for which Offer peer review and comment features for collaborative content or projects. Connect the learners with experts for mentoring. Utilize Multi-Media Tools Videos, podcasts, info-graphics, etc. for providing information in an interactive format. Make use of interactive tools like polls, quizzes, live chat features, etc. to create activity and encourage learning. Promote Reflective Practice Exchange of thoughts on experience encountered at work, challenges overcome and achievements obtained. Likewise, it could be carried out through online diaries or blogging for recording and reflection of learning processes and results.

Organization and Membership in Learning Communities Active sharing by means of group and forum membership for learning goals. Setting up new learning groups/networks for particular interest or need. Incorporate game-based learning and employ learning games or/and challenges that can be shared and accessed through social media. Rewards or badges system for learning achievement or production of quality content. Foster Continuous Interaction and provide regular interaction with your network in order to maintain the learning process dynamic and current. Have feedback receiving and providing mechanisms in place to promote a culture of ongoing improvement. These methods can facilitate the creation of a dynamic, interactive and rich learning environment that is in line with Connectivism's principles in the digital media era.

Findings of the Study

The paper's stronger point in support of use of this new pedagogy is that although this new pedagogy, connectivism, is so easily enabled by any number of digital tools and web platforms, it can undoubtedly assist significantly towards improved learning outcomes through the greater provision of variegated opportunities to learn and freedom to learn in whatever style is most effective for them. The researcher research discovers that it prioritizes learner autonomy and dynamic

interaction in the learning networks that entails unlimited knowledge expansion. Argued on the basis of the findings, it is advised that the problems of implementing connectivism in forms of formal education have been properly observed on the matter of accessible infrastructural base, the requirement of proper training of teachers and filling the gap of digital literacy at the center of the students. Assessment practices that penetrate skills competencies such as problem-solving, flexibility and networking would be aligned to the principles of connectivism.

Conclusion

Digital pedagogies have reshaped the learning environment by providing personalized, interactive and inclusive learning experiences. With continuing advancements in technology, it is important for policymakers and teachers to embrace digital innovations along with solving the accompanying challenges. By following this, digital pedagogies can make learners and teachers more empowered, making the education system more inclusive and future-oriented. In the age of technology, when learning is ever more mediated by technology and within complex networks, connectivism is sensible as a theoretical framework. This theory runs counter to prevailing assumptions about the place of networks, the fragmentation of knowledge and the consideration of decision-making within the learning process. Connectivism provides a useful lens through which to consider the way in which the educational terrain is changing with technological progress. Social media is an excellent platform for building networks for information sharing, enhancing collaboration, enhancing critical thinking and even facilitating real-time feedback in the context of connectivist learning. Incorporation of social media in education processes undoubtedly aligns with principles of connectivism by providing new avenues for learners' connection, sharing and development in a digitally networked world. The greatest potential and threats to the connectivist learning are given by digital media: it provides greater access to information, better quality and diversity of views and offers a few opportunities to learn collaboratively. Conversely, it can pose such threats as overload of information, quality issues and privacy. To this extent, carefully constructed integration of online media into the learning environment is needed in order to assist students in taking optimal benefits and minimizing potential detriments. Pedagogy based on connectivism thus holds tremendous potential by capitalizing on networks' power in making available more collaborative, autonomous and life-long learning spaces. But these chances are threatened by obstacles and consist of the digital divide

and information overload, together with assessment problems. Thus, careful planning and proper infrastructure for digital tools needs to be given as support to both learners and teachers and to making connectivism available to successful application in various contexts. Thus the reimagining of pedagogies for the digital age will be successfully adopted.

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Preparing Teachers Beyond Content Delivery: Towards Transformative Pedagogies and Holistic Professional Development

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Abstract

Traditional teacher programme has long prioritized subject expertise and content delivery. However, evolving educational demands—informed by global frameworks like SDG 4, OECD Learning Compass 2030, and India's NEP 2020—call for a broader conceptualization of teacher readiness. This article critically examines the need to prepare teachers beyond content mastery, emphasizing inclusive pedagogies, socio-emotional learning, critical inquiry, technology integration, and reflective practice. Drawing on global and India-specific research—including empirical studies, policy analyses, and practitioner accounts it identifies gaps in current teacher education programme and proposes models that represent transformative professional development. Key competencies are explored in depth like experiential, mentorship, and action research based teacher education approaches. Systemic challenges including rigid curricula, resource limitations, and misaligned assessment structures are analyzed. The paper concludes with evidence-based strategies: redesigning teacher education curricula, strengthening school university linkages, embedding continuous professional development, and initiating policy reforms aligned with transformative aims. By integrating diverse perspectives and documented outcomes, this work presents actionable insights to support educators who guide holistic learning and cultivate equitable, inclusive classrooms.

Keywords: *Transformative Pedagogies, Holistic Development, SDG 4, NEP-2020, OECD Learning Compass 2030*

Introduction

Teacher education has historically emphasized mastery of content and the effective delivery of curricula—a legacy of behaviorist approaches where teaching is viewed as

knowledge transmission (Shulman, 1986). Though subject expertise is foundational, such an approach is proving inadequate in preparing teachers to cultivate deeper learning, critical thinking, creativity, and social–emotional capabilities among learners (OECD, 2020).

Global directives—such as the United Nations' Sustainable Development Goal 4, aimed at ensuring inclusive and equitable quality education—underscore that teachers must foster not only cognitive skills but also ethical awareness, emotional intelligence, and global citizenship (UNESCO, 2016). The OECD's Learning Compass 2030 highlights transformative competencies like navigating complexity, cooperating across cultures, and taking responsibility for one's learning (OECD, 2020). Concurrently, India's National Education Policy 2020 advocates a shift toward holistic development, multilingualism, experiential learning, and critical pedagogy (Ministry of Education, 2020). It envisions teacher preparation as more than an academic exercise—it is foundational to fostering learners who can engage with the complex environments of the 21st century.

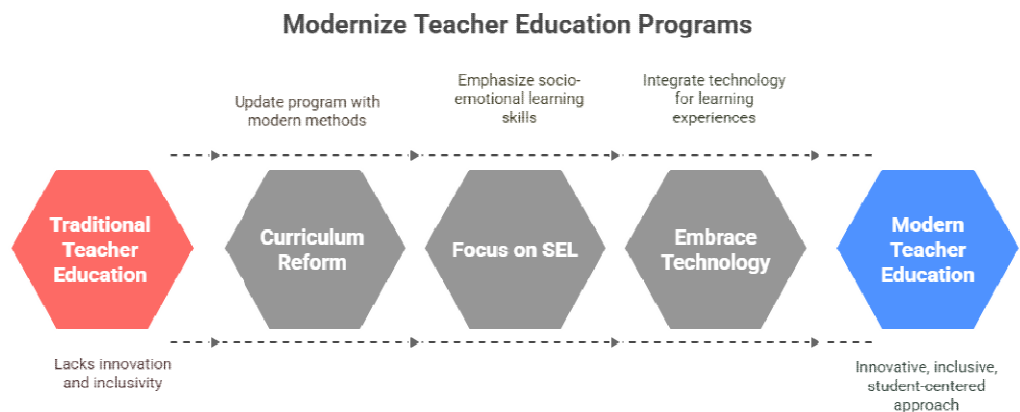
Converging Visions for 21st-Century Teacher Preparation



21st –Century Teacher Preparation

Figure-1

Despite these progressive frameworks, many teacher education programs remain anchored in traditional structures. They focus on concept mastery, lesson planning, and a standardized assessment culture that leaves little room for innovation or the cultivation of inclusive, student-centered approaches (Dar & Ganaie, 2021; Chaturvedi, 2023). With rising classroom diversity, growing emphasis on socio-emotional learning (SEL), and rapid technological shifts, educators need to be equipped for much more than effective content delivery—they need to lead transformative learning experiences.



Modernize Teacher Education Programs

Figure-2

This paper explores how teacher preparation can transcend content delivery. It seeks to answer: What competencies constitute transformative teaching? What program models effectively instantiate them? What systemic constraints must be addressed? Guided by global and Indian insights—including policy reviews (Nandi, Das, & Halder, 2022; Sarkar & Yadav, 2023)—the paper offers strategic recommendations for redesigning teacher education toward more holistic, reflective, and inclusive frameworks.

Literature Review

Pedagogical Content Knowledge (PCK) remains recognized as crucial for integrating subject knowledge with how learners construct meaning (Shulman, 1986). Yet many teacher programs concentrate on content mastery and standardized lesson delivery, neglecting dimensions like inclusive teaching, emotional intelligence, and reflective practice (Dar & Ganaie, 2021). This faculty-centered paradigm limits teachers’ capacities to interpret learning barriers or embrace pedagogical diversity.

Inclusive education literature emphasizes the need for teachers skilled in differentiated instruction, Universal Design for Learning (UDL), and accommodation of learners with special needs or differing backgrounds (Sarkar & Yadav, 2023). However, such competencies are often sidelined in curriculum design, resulting in insufficient preparation for real-world classroom diversity.

Socio-emotional learning (SEL) in teachers correlates strongly with more empathetic and effective classroom engagement (Dar & Ganaie, 2021). Still, SEL remains peripheral in many educational programs, despite being critical for teacher well-being and student–teacher rapport.

Empirical reviews show that impactful teacher education blends theory with guided practice. Mentorship, reflection, and sustained field experience enhance candidates' preparedness for classroom complexity (Chaturvedi, 2023). Action research enables teachers to investigate their practices contextually and iteratively, fostering professional growth and adaptability.

Indian-focused analyses of NEP 2020 identify its strengths—such as emphasis on interdisciplinary learning, multilingualism, and teacher professionalism—but criticize gaps in implementation, noting underfunded programs, insufficient teacher preparation for inclusive pedagogy, and outdated assessment mechanisms (Nandi et al., 2022; Babu, 2023).

Global scholarship complements these findings. Sleeter (2001, 2008) emphasizes cultural competence for diverse classrooms. Cochran-Smith et al. (2016) argue that socially just teacher education must disrupt hierarchical norms and empower teachers as agents of change. Davies and Davis (2019) highlight the transformative power of mentoring and community immersion in teacher training globally. Such perspectives inform a unified argument: teacher preparation must evolve beyond content proficiency to meet the demands of inclusivity, reflection, and responsiveness in diverse settings.

Key Competencies Beyond Content Delivery

Inclusive Learning Design

Teachers must be adept at designing learning environments that accommodate linguistic, cultural, and ability differences. UDL and differentiated instruction frameworks support this practice. For example, Sarkar and Yadav (2023) indicate that NEP 2020's inclusive education goals require teachers to employ flexible teaching modes that respond to diverse learner needs.

Critical Thinking and Learner Inquiry

Transformative pedagogies require fostering intellectual curiosity through inquiry-based and project-based learning. Teachers should be able to facilitate student-led exploration—not just deliver answers. This aligns with OECD's emphasis on future-ready reasoning skills (OECD, 2020).

Technology-Enhanced Pedagogy

Teachers need to use digital tools to support collaboration, reflection, and personalized learning. Practices such as flipped classrooms and e-portfolios, grounded in intentional pedagogical design, shift technology from mere medium to learning catalyst (UNESCO, 2016).

Socio-Emotional Competence

Self-awareness, emotional regulation, and relationship-building are critical for managing classroom climate. Teacher well-being initiatives such as Saharaline—a

WhatsApp-based support network in low-income Indian schools—highlight the power of emotional and peer support structures (Varanasi et al., 2024).

Reflective and Practitioner Research

Engaging in action research encourages teachers to analyze their practice and adapt with evidence. Cochran-Smith et al. (2016) argue that “teachers as researchers” is a powerful model for enhancing professional judgment and autonomy.

Models for Transformative Teacher Education

- **Experiential Learning and Mentoring:**

Early, structured immersion in classrooms—accompanied by coaching and reflection—develops practical skills and adaptive capacity (Chaturvedi, 2023). Mentorship counters the gap between theory and practice and embeds reflective cycles into learning.

- **Action-Research-Based Preparation:**

Teachers engage in classroom-based inquiry to identify problems, test pedagogical strategies, and implement solutions. This model aligns with teacher as reflective practitioner and supports continuous improvement (Cochran-Smith et al., 2016).

- **Community-Engaged Teacher Education:**

Placing teacher candidates within community settings promotes cultural responsiveness and contextual understanding. Davies and Davis (2019) note how this fosters deeper empathy and social awareness.

- **Blended Models:**

Combining face-to-face and online components—including peer forums, video reflections, and virtual simulations—supports flexible and reflective learning. It accommodates individual learning paces and teaching styles.

Challenges to Implementation

- **Curriculum Inertia and Regulatory Barriers**

Reports indicate entrenched curricula and accreditation systems limit innovation (Nandi et al., 2022). Institutions often lack capacity or motivation to adopt progressive frameworks.

- **Assessment Misalignment**

High-stakes testing privileges content recall over higher-order strategies or inclusive teaching. Without reform, curricula cannot shift meaningfully (Babu, 2023).

- **Resource and Infrastructure Constraints**

Institutions face constraints in time, funding, and human capital, limiting their ability to implement intensive mentoring or action-research programs (Chaturvedi, 2023).

- **Policy–Practice Gaps**

Though NEP 2020 advocates transformative teaching, its translation into practice remains inconsistent due to fragmented oversight and weak systemic coordination (Babu, 2023; Singh, 2025).

- **Cultural and Attitudinal Barriers**

Hierarchical teacher–student relationships, resistance to partnership models, and exam-driven mindsets inhibit Student-Centered Learning (SCL) adoption.

Recommendations

1. Curriculum Redesign around Core Competencies

Teacher education programs must integrate modules on inclusivity, SEL, enquiry-based pedagogy, and reflective practice—not as electives but as core elements. This aligns with NEP 2020’s call for multidisciplinary and holistic training (Ministry of Education, 2020).

2. Strengthened School–University Collaboration

Partnership models should embed field experiences, co-teaching, and sustained mentoring, allowing candidates to translate theory into practice within diverse classrooms (Chaturvedi, 2023). Local education ecosystems must support such partnerships.

3. Continuous Professional Development (CPD)

Institutionalize CPD as a lifelong teacher entitlement. This could include workshops, peer learning groups, digital communities, and incentives for practitioner research and innovation.

4. Policy Incentives and Accreditation Realignment

Regulatory bodies should revise accreditation and evaluation criteria to reward programs that produce inclusive, inquiry-oriented teachers. Higher education funding must prioritize institutions demonstrating grassroots impact.

5. Capacity Building for Teacher Educators

Instructor training in mentorship, action research, and digital pedagogies is crucial. Networks of practice—including cross-institutional exchange—can foster professional growth and innovation.

6. Embedding Reflective Inquiry Practices

Incorporate structured reflection and action research into program coursework. Documenting teacher inquiry through portfolios, case studies, or action research journals cultivates a habit of professional inquiry.

7. Leveraging Technology for Support Networks

Expand initiatives like Saharaline to create digital platforms for peer support, mentoring, and resource sharing—especially for teachers working in low-resource environments (Varanasi et al., 2024).

Conclusion

In an era of educational complexity, teacher preparation must transcend the act of content delivery and cultivate transformative capacities. Through a critical synthesis of global frameworks and Indian policy studies, this article argues that teachers must be prepared to design inclusive learning environments, engage in inquiry-based teaching, integrate technology mindfully, support socio-emotional development, and embrace ongoing reflection. Models rooted in experiential learning, mentorship, action research, and community engagement demonstrate positive outcomes where implemented.

Yet systemic obstacles—rigid curricula, misaligned assessment, resource constraints, and cultural resistance—pose significant challenges. Policy reforms, accreditation restructuring, and institutional investments are essential to drive change. Embedding reflective inquiry, building digital and peer support systems, and upskilling teacher educators can activate this shift.

Ultimately, preparing teachers beyond content delivery is not just a curricular enhancement—it is a socio-educational imperative. It demands a shift in how we perceive teacher professionalism and its role in shaping future-ready learners. If realized, such a shift holds the promise of more equitable, engaging, and resilient educational ecosystems.

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Teacher Preparation for Multilingual and Multicultural Classrooms

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Abstract

India's cultural and linguistic diversity presents both a rich opportunity and a significant challenge in the field of education. The National Education Policy (NEP) 2020 recognizes this diversity and proposes reforms to ensure inclusive, equitable, and holistic education through multilingual and multicultural approaches. This chapter explores the implications of NEP 2020 for pre-service teacher education, focusing on the development of competencies required to effectively teach in multilingual and multicultural classrooms. It analyzes the policy's recommendations regarding the medium of instruction, promotion of mother tongues and regional languages, and the integration of cultural knowledge into pedagogical practices. The chapter further examines strategies for enhancing teacher preparedness through culturally responsive teaching, inclusive curriculum design, and professional development modules. It emphasizes the importance of equipping future teachers with the skills to foster inclusive classroom environments that respect linguistic and cultural differences while promoting national unity. Through critical analysis, best practices, and case illustrations, the chapter offers a roadmap for reimagining teacher education programs in alignment with the goals of NEP 2020.

Keywords : *Multilingual Education, Multicultural Classrooms, National Education Policy 2020, Pre-Service Teacher Education, Inclusive Pedagogy*

Introduction

India, a nation marked by an extraordinary mosaic of cultures, languages, ethnicities, and religions, presents a unique educational landscape. With 22 officially recognized languages in the Eighth Schedule of the Indian Constitution and hundreds of dialects spoken across the country, the classroom becomes a microcosm of this diversity. In such a context, education must go beyond the mere transmission of knowledge to become a transformative process that fosters inclusivity, mutual respect, and national integration. The National Education Policy (NEP) 2020 acknowledges this complexity and attempts to create a framework that supports linguistic plurality

and cultural multiplicity in Indian classrooms, particularly at the foundational levels and in teacher education programs (Ministry of Education [MoE], 2020).

The NEP 2020 marks a paradigm shift in India's educational vision. It emphasizes the integration of local culture and mother tongue as mediums of instruction during early schooling, promoting a child's cognitive development and identity formation (MoE, 2020). Recognizing the importance of home language in the learning process, the policy suggests that wherever possible, the medium of instruction until at least Grade 5, and preferably till Grade 8 and beyond, should be the mother tongue or local/regional language. This multilingual focus is not only an educational strategy but also a socio-political move to preserve India's linguistic heritage and promote equity in learning.

In tandem with multilingualism, multiculturalism is another crucial theme in NEP 2020. India's multicultural reality requires the education system to move away from a "one-size-fits-all" model and adopt inclusive pedagogical practices that reflect the sociocultural backgrounds of learners. As Banks (2015) suggests, multicultural education promotes democratic values and cultural pluralism by preparing students to function in an increasingly diverse society. It is imperative that teacher education programs align with this vision by preparing pre-service teachers to address the needs of diverse classrooms with sensitivity and adaptability.

The multicultural classroom in India is characterized not only by linguistic variation but also by differences in caste, religion, ethnicity, gender, socioeconomic status, and regional identity. These differences often intersect, creating complex educational realities that require nuanced pedagogical responses. Pre-service teachers must therefore be trained not only in subject matter content but also in cultural competence, empathy, and inclusive strategies that recognize and value student diversity (Gay, 2010).

One of the central tenets of NEP 2020 is the holistic development of learners. This goal cannot be achieved without addressing the challenges posed by linguistic and cultural barriers in education. Research has shown that children learn best in their home language, especially in the early years, as it allows for better comprehension and cognitive engagement (UNESCO, 2016). Moreover, when students see their language and culture reflected in the classroom, it validates their identity and fosters a sense of belonging, which is essential for academic motivation and success

(Cummins, 2000). NEP 2020's emphasis on multilingualism is thus not merely linguistic policy but a commitment to social justice and inclusive education.

However, the transition from policy to practice is fraught with challenges. India's teacher education system has traditionally been centralized and standardized, often neglecting regional needs and linguistic diversity. Teacher education programs frequently focus on content knowledge and pedagogy but fail to address the sociocultural contexts of learners. Pre-service teachers often enter the profession without the tools to engage with multilingual or multicultural classrooms effectively. As Ladson-Billings (1995) argues, effective teachers in diverse classrooms are those who possess a deep understanding of the cultural backgrounds of their students and use that knowledge to inform their teaching strategies.

NEP 2020 recognizes the role of teachers as the cornerstone of the education system. It emphasizes the need for a rigorous and well-rounded teacher education system that incorporates multilingual and multicultural perspectives. The policy proposes the establishment of integrated B.Ed. programs that include training in inclusive education, cross-cultural understanding, and local context-based teaching methodologies (MoE, 2020). The curriculum for teacher education is envisioned to be interdisciplinary, rooted in Indian values, and adaptable to local realities. This vision provides an opportunity to reimagine pre-service teacher education in a way that aligns with the pluralistic ethos of Indian society.

Furthermore, the NEP 2020 highlights the importance of equity and inclusion as foundational principles of education. It stresses that disadvantaged and underrepresented groups—including linguistic minorities, tribal communities, and economically weaker sections—must receive special support to access and benefit from education. Teacher education programs, therefore, must equip future teachers with the ability to create inclusive classrooms that address the needs of all learners, regardless of their background. This requires training in differentiated instruction, multilingual resources, culturally responsive assessment, and sensitivity to issues of social justice and equity (Banks, 2013).

Another significant aspect of NEP 2020 is its endorsement of experiential learning, critical thinking, and competency-based education. These pedagogical shifts require teachers who can navigate and integrate diverse perspectives into the learning environment. In multilingual and multicultural classrooms, this means designing lessons that draw on students' lived experiences, encouraging dialogue among

cultures, and promoting linguistic pluralism. Pre-service teachers need to develop the skills to create such learning spaces through both theoretical understanding and practical exposure.

In practice, this can be facilitated through internships, school immersion programs, community engagement, and reflective teaching practices embedded in teacher education curricula. By spending time in diverse school settings, pre-service teachers can observe and analyze the dynamics of multilingual and multicultural interactions and develop strategies for inclusive teaching. Such experiential components are crucial in bridging the gap between theory and practice in teacher education.

Additionally, the integration of digital tools and technology in education—as emphasized by NEP 2020—provides opportunities for supporting multilingual learners and accessing culturally diverse content. Teachers can use digital platforms to provide translations, subtitled videos, language learning apps, and culturally relevant resources. However, the effective use of technology also depends on the teacher’s awareness, training, and motivation. Hence, digital literacy must be accompanied by cultural literacy in teacher preparation.

The success of NEP 2020's vision rests on the ability of teacher education institutions to redesign their programs to reflect the multilingual and multicultural realities of Indian society. This involves revising syllabi, retraining faculty, developing context-specific resources, and fostering a mindset that values diversity as an asset rather than a challenge. Collaboration with local communities, language experts, and cultural organizations can also enrich teacher education and ensure that it remains grounded in real-life experiences.

NEP 2020 and Multilingual Classrooms

India’s linguistic landscape is among the richest in the world, with over 19,500 languages and dialects spoken across its regions (Census of India, 2011). Recognizing this diversity, the National Education Policy (NEP) 2020 places multilingualism at the heart of its vision for equitable and inclusive education. The policy aims to transform the educational experience for students by embracing their linguistic identities, particularly during the formative years of learning. The implementation of multilingual education is presented not only as a pedagogical strategy but also as a tool for national unity, social cohesion, and academic success.

Policy Goals and Recommendations

NEP 2020 outlines several key recommendations to promote multilingualism within the Indian education system, particularly at the school level:

1. Mother Tongue or Regional Language as Medium of Instruction

The most significant recommendation is the use of the mother tongue or local/regional language as the medium of instruction at least until Grade 5, and preferably till Grade 8 and beyond (MoE, 2020). This recommendation is grounded in research suggesting that early education in the child's home language leads to better cognitive development and stronger foundational learning outcomes (UNESCO, 2016; Cummins, 2000).

2. Promotion of the Three-Language Formula

NEP 2020 reiterates the modified three-language formula, encouraging students to learn three languages – two of which must be native to India. Flexibility is emphasized, allowing states and schools to adapt to local linguistic needs. This is designed to promote national integration while preserving local languages and cultures (MoE, 2020).

3. Curricular and Pedagogical Support

The policy emphasizes the development of bilingual teaching-learning materials and training teachers to facilitate instruction in multiple languages. It also promotes the integration of classical and tribal languages into the curriculum to ensure inclusivity for marginalized linguistic communities.

4. Language Resource Centres and Technology Integration

NEP 2020 calls for the creation of language resource centres and the use of technology and AI-based tools for translation and content delivery in multiple languages to support both teachers and learners in multilingual environments.

5. Teacher Preparation and Language Sensitization

Importantly, the policy mandates that pre-service teacher education programs must train future teachers in the pedagogical strategies of multilingual education. This includes raising awareness about language rights, inclusive classroom practices, and the use of local languages in teaching.

Challenges in Implementing Multilingual Education

While the policy aspirations are laudable, several implementation challenges persist:

1. Shortage of Trained Multilingual Teachers

One of the most critical issues is the lack of teachers proficient in multiple languages or trained in multilingual pedagogy. Many teacher education institutions do not offer adequate modules on multilingual instructional strategies, especially for tribal or lesser-spoken languages.

2. Scarcity of Teaching-Learning Materials

Schools across India face a shortage of textbooks, digital content, and instructional resources in mother tongues and regional languages. Even when materials exist, their quality and accessibility vary widely.

3. Resistance from Urban and English-Medium Stakeholders

A growing preference for English-medium education, especially in urban and semi-urban areas, often leads to resistance from parents and school administrators who associate English with better employment prospects. This presents a sociocultural challenge in implementing mother tongue instruction (Mohanty, 2009).

4. Administrative and Policy-Level Disparities

The decentralized nature of language policy implementation across states can lead to inconsistencies in execution. While some states actively promote regional languages, others lack political will or infrastructure to do so.

5. Assessment and Evaluation Barriers

Standardized assessments are often conducted in dominant or official languages, which can disadvantage learners from diverse linguistic backgrounds. Adapting evaluation methods to support multilingual learners remains a critical gap.

Opportunities in Implementing Multilingual Education

Despite the challenges, NEP 2020 opens up several opportunities for transformation:

- **Reinforcement of Cultural Identity** :Allowing children to learn in their mother tongue helps in preserving linguistic heritage and fosters a positive sense of self and community, which is essential for emotional and social development.
- **Improved Learning Outcomes** :Research has consistently shown that children taught in their home languages perform better in comprehension and

conceptual understanding in early grades (Ball, 2010). This lays a strong foundation for lifelong learning and academic achievement.

- **Development of Multilingual Competence** :Exposure to multiple languages enhances cognitive flexibility, problem-solving ability, and communication skills. The three-language formula ensures that students develop multilingual proficiency, positioning them better for higher education and employment in a globalized world.
- **Empowerment of Marginalized Communities** :When tribal and minority languages are incorporated into education, it leads to greater participation of marginalized communities and strengthens educational equity and social inclusion.
- **Integration with Digital Platforms** :Digital tools, including e-content, AI-based translation, and voice-assisted learning, offer scalable solutions for creating multilingual resources that can reach remote and underserved regions.

NEP 2020 and Multicultural Classrooms

India's classrooms are not only multilingual but also deeply multicultural, reflecting the country's vast array of ethnicities, religions, social strata, customs, and traditions. National Education Policy (NEP) 2020 recognizes this reality and embraces it as a foundation for building inclusive, equitable, and holistic education. Rather than treating diversity as a challenge, the policy promotes it as an opportunity for mutual learning, respect, and growth.

Inclusive Practices for Diverse Student Populations

NEP 2020 emphasizes inclusivity in education by addressing the needs of students from various socio-cultural backgrounds. Chapter 6 of the policy, titled *Equitable and Inclusive Education*, provides clear directions to “ensure that no child loses any opportunity to learn and excel because of the circumstances of birth or background” (MoE, 2020, p. 24). This includes ensuring access to education for students from Scheduled Castes (SC), Scheduled Tribes (ST), Other Backward Classes (OBC), minorities, girls, and children with disabilities.

Key inclusive practices highlighted in NEP 2020 include:

- Culturally responsive pedagogy that reflects students' experiences and cultural knowledge in the teaching-learning process.

- Use of local knowledge systems and traditional practices in curriculum design to foster respect for heritage.
- Formation of Inclusion Funds at central and state levels to support socio-economically disadvantaged groups (SEDGs).
- Establishment of Special Education Zones (SEZs) to support areas with concentrated SEDG populations.

Training Pre-Service Teachers in Cultural Sensitivity and Awareness

One of the critical mandates of NEP 2020 is to reimagine teacher education. As classrooms become increasingly diverse, the development of cultural competence among teachers becomes imperative. NEP 2020 recommends a four-year integrated B.Ed. program to be the minimum degree requirement for teaching by 2030. This restructured program must include core courses that prepare future teachers for diverse classrooms.

The National Curriculum Framework for Teacher Education (NCFTE), aligned with NEP 2020, stresses the importance of sensitizing pre-service teachers to:

- Issues of caste, gender, religion, and language in educational contexts.
- The importance of equity and social justice.
- The ability to interact respectfully and empathetically with students and families from diverse backgrounds.

Teacher education institutions (TEIs) are now tasked with not just training teachers in subject knowledge but also helping them become agents of inclusion and social cohesion (NCTE, 2021).

Strategies for Pre-Service Teacher Education

Preparing pre-service teachers for diverse classrooms demands a shift from traditional methods to culturally sustaining pedagogies and reflective practices. Below are critical strategies to embed in teacher education programs:

Cross-Cultural Communication Skills

Effective communication across cultures is vital for building inclusive classrooms.

Pre-service teachers should be trained to:

- Recognize non-verbal cues, dialects, and idioms that vary across cultures.
- Practice active listening and empathetic dialogue with students and parents.
- Facilitate multilingual conversations and scaffold language use for comprehension and expression.

Simulation exercises, community immersion programs, and role-playing activities can support the development of cross-cultural communication.

Classroom Management Techniques in Diverse Settings

Classroom management in multicultural contexts must account for differences in values, behaviors, and learning styles. Pre-service teachers should learn to:

- Build mutual respect and trust among students of different backgrounds.
- Address biases and stereotypes that may arise in classroom interactions.
- Design inclusive seating plans, group activities, and assessment practices.

Training in restorative practices, conflict resolution, and trauma-informed teaching can be especially helpful in managing emotionally complex and diverse environments.

Collaborative Learning Approaches that Celebrate Diversity

Collaborative learning strategies such as peer tutoring, group projects, and cooperative learning provide opportunities for students to engage across cultures.

Teacher education should focus on:

- Structuring group tasks that encourage cultural sharing and exchange.
- Using case studies and storytelling that represent diverse voices.
- Promoting student agency by incorporating local narratives and community projects.

Such approaches not only build intercultural understanding but also enhance engagement and academic outcomes.

Conclusion

The National Education Policy (NEP) 2020 represents a transformative step forward in reimagining the Indian education system through the lens of inclusivity, diversity, and equity. By explicitly addressing the realities of multilingual and multicultural classrooms, the policy reaffirms India's constitutional commitment to justice, equality, and fraternity in education. It recognizes diversity not as a challenge but as a strength that can enhance the quality of teaching and learning when approached with sensitivity and strategic planning.

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Challenges of Implementing the Integrated Teacher Education Programme (ITEP)

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Abstract

ITEP introduces important changes to teacher education practices that follow guidelines from NEP 2020. Its main target is academic education integration with pedagogical instruction to provide teachers optimal preparation for modern educational changes. The enormous potential of Integrated Teacher Education Programme to enhance Indian teacher education faces substantial obstacles during its current deployment phase. Multiple challenges need effective solutions for the successful execution of ITEP. The program faces multiple obstacles which stem from inadequate infrastructure, unprepared teaching staff, integration problems in the curriculum, regulatory requirements and a shortage of funding. Implementation hurdles multiply because of teacher education institutions' unwillingness to change along with the requirement of effective assessment and accreditation frameworks. For the successful transformation from separate to unified teacher education operations policy backing and capital strengthening together with faculty development initiatives will be vital. This chapter presents an extensive assessment of the impediments which block successful ITEP deployment by doing an in-depth examination of these obstacles. The development of an outstanding teacher workforce to lead educational progress demands the resolution of these obstacles in the 21st century.

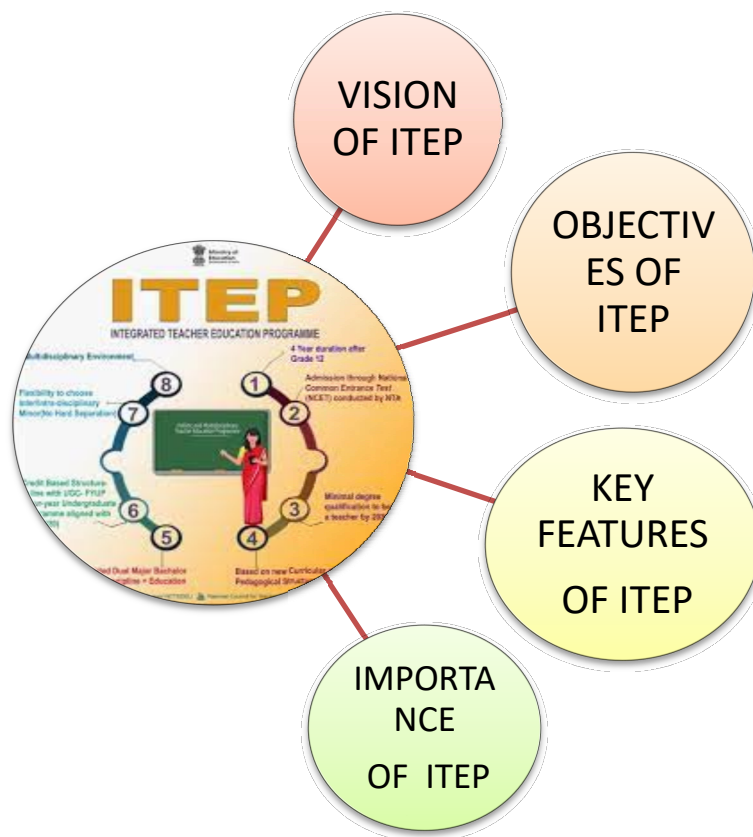
Keywords: *Integrated Teacher Education Programme (ITEP), National Education Policy 2020, Teacher education, Curriculum integration, Implementation challenges*

INTRODUCTION

Teacher education is a critical component of any educational system, as the quality of teachers directly influences the effectiveness of education delivered to students. Recognizing this, the Indian government introduced the Integrated Teacher Education Program (ITEP) as part of the National Education Policy (NEP) 2020. ITEP is a four-year comprehensive program that integrates undergraduate studies with teacher education, aiming to produce highly skilled and professionally competent teachers. By merging a bachelor's degree with teacher training, ITEP seeks to address the traditional gaps in teacher preparation, providing a more holistic approach to pedagogy, subject mastery, and practical teaching experience. However, the implementation of such a large-scale reform in teacher education has encountered several challenges.

The ITEP represents a paradigm shift in teacher preparation, aiming to replace fragmented and often disparate teacher education pathways with a cohesive, integrated approach. The vision is to produce teachers who possess a deep understanding of subject matter, pedagogical expertise, and a strong foundation in educational psychology and philosophy. This initiative is particularly timely in the context of the National Education Policy (NEP) 2020, which emphasizes the need for high-quality teacher education to drive educational transformation. However, the current educational scenario presents a complex backdrop for the implementation of ITEP. Factors such as rapid technological advancements, evolving student demographics, and the increasing emphasis on competency-based learning demand a flexible and responsive teacher education system. Moreover, the lingering effects of the COVID-19 pandemic have highlighted the importance of digital literacy and adaptability in education. The ITEP must navigate these complexities while ensuring equitable access and maintaining high standards.

OVERVIEW OF INTEGRATED TEACHER EDUCATION PROGRAMME (ITEP)



OVERVIEW OF ITEP

Figure-1

➤ Vision of ITEP:

The Integrated Teacher Education Programme (ITEP) is a four-year undergraduate initiative designed to revolutionize teacher education in India. Its vision aligns with the National Education Policy (NEP) 2020, aiming to produce educators who are not only subject matter experts but also adept in modern pedagogical techniques. The programme emphasizes critical thinking, creativity, inclusivity, and ethics, preparing educators to adopt learner-centred methodologies while contributing to a diverse society.

Objectives of ITEP:

The primary objectives of ITEP are:

- To integrate general education with professional teacher training.
- To provide a holistic understanding of pedagogy, curriculum, and assessment methodologies.
- To prepare well-rounded educators with interdisciplinary knowledge and practical teaching experience.
- To ensure that teachers are equipped with 21st-century skills, including digital literacy, critical thinking, and effective communication.
- To streamline the teacher preparation process by replacing the traditional Bachelor of Education (B.Ed.) degree with a more structured and research-based program.

Key Features of ITEP

- **Structure and Duration**

- Four-year integrated program
- Combination of subject knowledge and pedagogical training
- Internship and fieldwork components

- **Curriculum Components as per NEP 2020**

- Multidisciplinary approach with focus on foundational literacy and numeracy
- Inclusion of Indian knowledge systems and values-based education
- Emphasis on digital literacy and emerging pedagogies

- **Pedagogical Innovations**

- Experiential learning and activity-based methodologies
- Integration of technology in teaching and learning
- Focus on competency-based and learner-centric approaches

- **Assessment and Accreditation Mechanisms**

- Continuous and comprehensive evaluation
- Standardized teacher eligibility criteria
- National and state-level accreditation frameworks

- **Eligibility and Admission**

- Completion of higher secondary education (10+2) from a recognized board.
- Meeting the eligibility requirements set by respective universities and teacher education institutions.

- Clearing national or state-level entrance exams, as mandated by educational authorities

Importance of ITEP

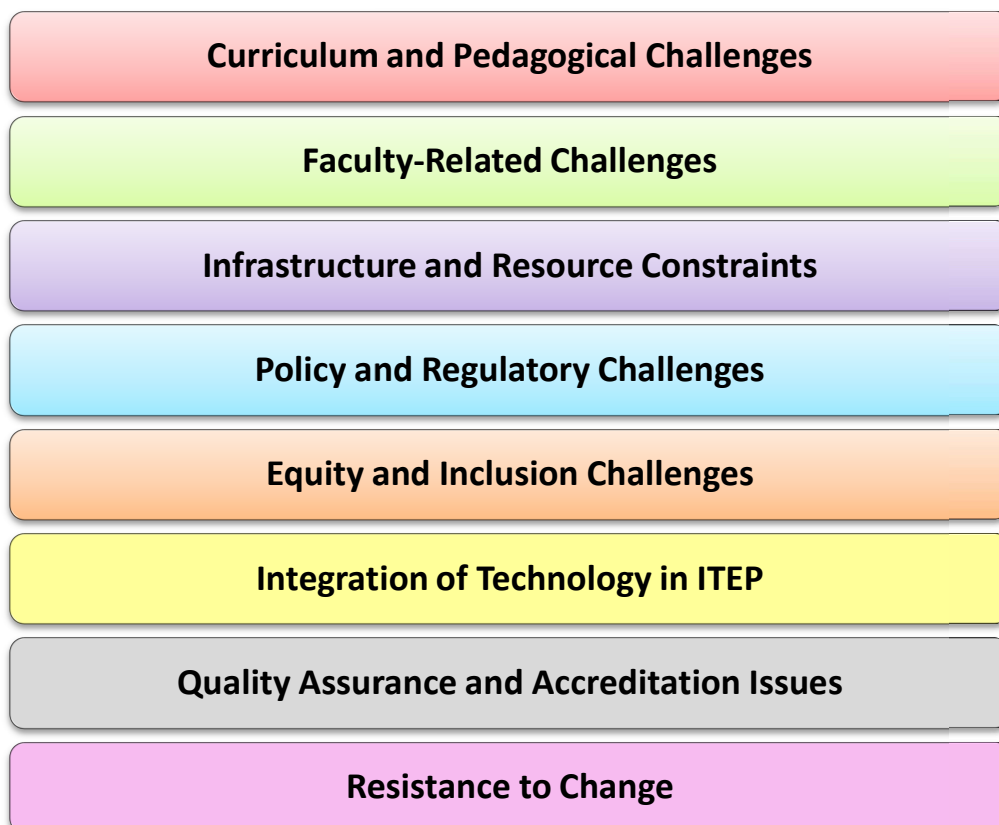
Key Aspects Highlighting the Importance of ITEP:

- 1. Comprehensive Teacher Preparation:** ITEP is a four-year undergraduate program that integrates general education with professional teacher training. This structure ensures that prospective teachers acquire both subject matter expertise and pedagogical skills, leading to more effective teaching practices.
- 2. Alignment with NEP 2020 Objectives:** NEP 2020 proposes a shift from the traditional 10+2 schooling system to a 5+3+3+4 model, focusing on foundational, preparatory, middle, and secondary stages. ITEP prepares teachers to effectively engage with students across these stages, ensuring a seamless transition and continuity in learning experiences.
- 3. Elevating Teacher Quality:** By setting ITEP as the minimum qualification for teaching positions by 2030, NEP 2020 aims to standardize and elevate the quality of teacher education. This move addresses the variability in teacher training programs and ensures a consistent standard of teaching proficiency nationwide.
- 4. Holistic Development of Educators:** ITEP emphasizes a multidisciplinary approach, combining theoretical knowledge with practical training. This holistic development equips teachers with the necessary skills to adapt to diverse classroom scenarios and cater to the varied learning needs of students.
- 5. Streamlined Entry into the Teaching Profession:** Traditionally, becoming a teacher involved completing a bachelor's degree followed by a B.Ed. program, totaling five years. ITEP consolidates this pathway into a four-year program, making the process more efficient and attractive to aspiring educators.
- 6. Promotion of Research and Innovation:** The program encourages research-based practices and continuous professional development, fostering a culture of innovation in teaching methodologies. This aligns with NEP 2020's vision of promoting critical thinking and creativity in education.

- 7. Global Competitiveness:** By adopting international best practices in teacher education, ITEP positions Indian educators to be competitive globally, enhancing the overall standard of education in the country.

CHALLENGES IN IMPLEMENTATION OF ITE

The current educational landscape poses significant challenges for ITEP implementation. This presents several challenges:



CURRICULUM DESIGN AND INTEGRATION: A CORE CHALLENGE

A central challenge in implementing ITEP lies in the design and integration of the curriculum. The program aims to seamlessly blend general education with professional training, requiring a holistic and interdisciplinary approach. This necessitates:

- **Developing a Coherent Framework:** Creating a curriculum that effectively integrates subject knowledge, pedagogical content knowledge, and practical experience is crucial. This requires careful planning and collaboration among subject experts, teacher educators, and curriculum developers.

- **Balancing Theory and Practice:** Striking a balance between theoretical knowledge and practical skills is essential. The curriculum must provide ample opportunities for students to apply their learning in real-world classroom settings.
- **Addressing Diverse Needs:** The curriculum must be flexible enough to address the diverse needs of students and institutions, considering regional variations and specific subject specializations.
- **Incorporating Emerging Trends:** The curriculum must be regularly updated to incorporate emerging trends in education, such as digital literacy, inclusive education, and competency-based assessment.
- **Interdisciplinary Connections:** The curriculum needs to facilitate strong interdisciplinary connections. For example, a future science teacher should also understand the social implications of scientific advancements.
- **Assessment Strategies:** Designing assessment strategies that align with the integrated nature of the curriculum is critical. This involves moving beyond traditional exams to incorporate portfolios, projects, and performance-based assessments.

FACULTY PREPAREDNESS AND DEVELOPMENT: BUILDING CAPACITY

The success of ITEP hinges on the preparedness and competence of teacher educators. This presents several challenges:

- **Upgrading Faculty Skills:** Many existing faculty members may require training and professional development to adapt to the integrated curriculum and innovative teaching methodologies.
- **Attracting and Retaining Qualified Faculty:** Attracting and retaining qualified faculty members with expertise in both subject matter and pedagogy is crucial. This requires competitive salaries, research opportunities, and a supportive work environment.
- **Promoting Collaborative Learning:** Fostering a culture of collaborative learning and knowledge sharing among faculty members is essential for effective curriculum delivery.
- **Integrating Technology:** Training faculty in the effective use of educational technology is vital for preparing teachers for the digital age.

- **Pedagogical Content Knowledge:** Faculty must have strong pedagogical content knowledge, meaning they understand how to teach their subject matter effectively.
- **Mentorship and Support:** Providing mentorship and support to faculty members, especially those new to the integrated approach, is crucial.

INFRASTRUCTURE AND RESOURCE REQUIREMENTS: ENSURING EQUITABLE ACCESS

Implementing ITEP requires significant investment in infrastructure and resources, which can be a significant challenge, especially in resource-constrained environments. This includes:

- **Physical Infrastructure:** Adequate classrooms, laboratories, libraries, and technology infrastructure are essential for effective teaching and learning.
- **Digital Resources:** Access to digital resources, such as online learning platforms, digital libraries, and educational software, is crucial for preparing teachers for the digital age.
- **Financial Resources:** Sustained financial investment is needed to support faculty development, curriculum development, and infrastructure development.
- **Equitable Distribution:** Ensuring equitable distribution of resources across diverse institutions and regions is crucial for providing quality teacher education to all.
- **Technology Accessibility:** The digital divide must be addressed. Reliable internet access and sufficient devices must be available to all teacher candidates.
- **Practical Training Facilities:** Access to schools for practical training and internships is vital. This requires strong partnerships between teacher education institutions and schools.

POLICY AND GOVERNANCE: NAVIGATING THE REGULATORY LANDSCAPE

Effective policy and governance are essential for the successful implementation of ITEP. This involves:

- **Clear Policy Frameworks:** Developing clear and comprehensive policy frameworks that provide guidance on curriculum design, faculty development, and assessment.

- **Regulatory Clarity:** Establishing clear regulatory guidelines and standards for ITEP institutions to ensure quality and consistency.
- **Inter-Institutional Collaboration:** Fostering collaboration and coordination among different institutions and stakeholders involved in teacher education.
- **Continuous Monitoring and Evaluation:** Establishing mechanisms for continuous monitoring and evaluation to assess the effectiveness of ITEP and identify areas for improvement.
- **Flexibility and Adaptability:** Policies must be flexible enough to adapt to the evolving needs of the education sector.
- **Stakeholder Engagement:** Policy development must involve all stakeholders, including teacher educators, school administrators, and students.

ADDRESSING SOCIO-CULTURAL AND CONTEXTUAL FACTORS

The implementation of ITEP must consider the socio-cultural and contextual factors that influence teacher education. This includes:

- **Cultural Diversity:** Recognizing and addressing the cultural diversity of students and communities.
- **Language Diversity:** Providing language support for students from diverse linguistic backgrounds.
- **Socioeconomic Disparities:** Addressing the socioeconomic disparities that affect access to quality teacher education.
- **Regional Variations:** Adapting the curriculum and implementation strategies to the specific needs and contexts of different regions.
- **Community Engagement:** Fostering community engagement and collaboration in teacher education.
- **Inclusivity:** Ensuring that the program is inclusive and accessible to all students, regardless of their background or abilities.

INTEGRATING TECHNOLOGY EFFECTIVELY

Technology plays a vital role in modern education, and ITEP must effectively integrate technology into its curriculum and pedagogy. This involves:

- **Digital Literacy:** Developing the digital literacy skills of teacher candidates.
- **Online and Blended Learning:** Utilizing online and blended learning approaches to enhance teaching and learning.
- **Educational Software and Tools:** Integrating educational software and tools into the curriculum.

- **Data-Driven Instruction:** Using data to inform instruction and improve student outcomes.
- **Ethical Use of Technology:** Emphasizing the ethical use of technology in education.
- **Adaptive Learning:** Utilizing adaptive learning technologies to personalize instruction.

SUSTAINING QUALITY AND CONTINUOUS IMPROVEMENT

Ensuring the long-term quality and sustainability of ITEP requires a commitment to continuous improvement. This involves:

- **Regular Evaluation:** Conducting regular evaluations of the program to assess its effectiveness.
- **Feedback Mechanisms:** Establishing feedback mechanisms to gather input from students, faculty, and stakeholders.
- **Research and Innovation:** Encouraging research and innovation in teacher education.
- **Professional Development:** Providing ongoing professional development opportunities for faculty members.
- **Benchmarking:** Benchmarking against best practices in teacher education.
- **Adaptability:** Remaining adaptable to changing educational needs and trends.

INSTITUTIONAL RESISTANCE

- **Traditional Practices and Pedagogical Rigidities :** Educational institutions often resist changes in teacher education due to deeply ingrained traditional practices. Resistance to adopting innovative teaching methodologies and new assessment frameworks.
- **Resistance from Pre-Service Teachers :** Pre-service teachers may also resist new pedagogical approaches, especially if they are accustomed to traditional learning environments.
- **Bureaucratic and Administrative Barriers:** Institutions often face bureaucratic hurdles, including delays in policy implementation, complex accreditation processes, and rigid administrative structures.
- **Faculty Concerns and Workload Issues:** Faculty members may resist ITEP due to concerns over increased workload, additional training requirements, and the need for continuous professional development

CONCLUSION

The ITEP is a significant step towards improving the quality of teacher education in the current scenario. While the implementation challenges are substantial, they are not insurmountable. By addressing these challenges through strategic planning, collaboration, and investment, we can ensure that ITEP achieves its goals and produces highly competent and reflective teachers who are prepared to meet the demands of the 21st-century classroom. The future of education depends on the quality of our teachers, and ITEP has the potential to transform teacher preparation and empower future generations. Implementing ITEP successfully requires addressing multiple challenges, including policy inconsistencies, financial constraints, technological barriers, curriculum rigidity, faculty shortages, equity issues, and quality assurance gaps. A collaborative effort among policymakers, educators, and stakeholders is essential to create a sustainable and effective teacher education system. By prioritizing innovation, inclusivity, and continuous professional development, ITEP can fulfill its mission of preparing competent and adaptable teachers for the future.

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Teacher Education in NEP 2020: A New Era for English Subject Teaching at Secondary and Higher Secondary Schools in India.

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Abstract

The National Education Policy (NEP) 2020 represents a significant paradigm shift in India's education system. Moving away from traditional rote learning, it promotes a holistic, multidisciplinary, and competency-based framework aimed at developing critical thinking and creativity. Among its most impactful reforms is the overhaul of teacher education, with major implications for English subject teaching at the secondary and higher secondary levels. This paper critically explores the policy's vision for teacher education, the specific transformations proposed for English pedagogy, and the implications for teaching practices, curriculum, and teacher development in India. It also discusses the challenges and opportunities presented by NEP 2020 in establishing a dynamic and inclusive English language learning environment.

Keywords :NEP-2020, Multidisciplinary, English Language, Holistic Development

Introduction

India's linguistic diversity presents unique challenges and opportunities in language education. English, though not a native language, holds considerable value due to its global academic, professional, and socio-economic utility. At the secondary and higher secondary school levels, English is more than a language subject—it is a medium for accessing global knowledge and a tool for social mobility.

The National Education Policy 2020 envisions a transformative agenda for Indian education, especially in the realm of teacher preparation. For English teachers, NEP 2020 offers a new path through improved curricula, professional development, and learner-centred pedagogy, aiming to bridge the long-standing gaps between policy and practice.

Teacher Education in NEP 2020: A Strategic Overhaul

The Four-Year Integrated B.Ed. Programme

A key reform in NEP 2020 is the introduction of a four-year integrated B.Ed. degree, set to become the minimum qualification for teachers by 2030. This integrated model ensures:

- A blend of content knowledge and pedagogical theory specific to English.
- Interdisciplinary learning to foster adaptability and reflective practice among teachers.
- Emphasis on pedagogical content knowledge (PCK), contextualized to secondary English teaching.

Emphasis on Practice-Based Learning

Teacher education programs will incorporate robust school internships and field exposure. Aspiring English teachers will engage in:

- Classroom observation and discourse analysis.
- Peer teaching, lesson planning, and reflective journals.
- Exposure to multilingual and socio-culturally diverse classrooms.

Alignment with the National Curriculum Framework for Teacher Education (NCFTE)

The revamped NCFTE will align with the broader National Curriculum Framework for School Education (NCFSE). For English language teachers, this implies:

- Familiarity with second language acquisition theories.
- Competence in modern English Language Teaching (ELT) strategies.
- Skill development in holistic assessment techniques beyond standardized testing.

English Teaching in Secondary and Higher Secondary Schools: Context and Concerns

Key Challenges in English Pedagogy

Despite its critical role, English teaching at the secondary level remains fraught with challenges:

- **Overdependence on Grammar-Translation Method (GTM):** Teaching continues to rely heavily on outdated approaches, limiting students' communicative ability.
- **Neglect of Listening and Speaking Skills:** Language education is often narrowed to reading and writing for examination purposes.

- **Disparity in Learning Outcomes:** Students from rural or underprivileged backgrounds face unequal access to quality English instruction.

- **Teacher Preparedness:** Many English educators lack specialized training in ELT, which hampers effective classroom engagement.

Curriculum and Assessment Gaps: Current syllabi and assessment models overemphasize memory-based evaluation. NEP 2020's shift to competency-based education requires that English assessments evaluate practical communication, creative thinking, and application of knowledge in real-life contexts.

Implications of NEP 2020 for English Language Teaching (ELT)

Pedagogical Reorientation

NEP 2020 emphasizes constructivist and learner-centric pedagogies. In English classrooms, this necessitates:

- Transition from lecture-based teaching to interactive learning.
- Use of project-based learning, debates, dramatizations, and literature circles.
- Balanced development of the four core language skills: Listening, Speaking, Reading, and Writing (LSRW).

Multilingualism in English Education

While reaffirming the three-language formula, NEP 2020 also supports the development of English as a second language in a multilingual context. Teachers must:

- Use code-switching and translanguaging to support comprehension.
- Incorporate students' mother tongues strategically.
- Cultivate students' awareness of language structures and usage across languages.

Integration of Technology

Technology-enabled teaching is a cornerstone of the NEP vision. English educators are encouraged to:

- Utilize platforms like DIKSHA, SWAYAM, and e-Pathshala for digital content.
- Employ ICT tools—language apps, e-dictionaries, audio books, and video lessons—to enhance engagement.
- Design flipped classrooms and blended learning environments to promote student autonomy and participation.

Reforming the Teacher Education Curriculum for English

Strengthening Content Knowledge and Proficiency

Teacher education must ensure that English teachers have solid grounding in:

- Linguistic elements: phonetics, morphology, syntax, semantics, and pragmatics.
- A wide spectrum of literature: British, American, Indian, world, and postcolonial works.
- Current and evolving forms of English, including global varieties and digital communication styles.

Inclusive and Differentiated Instruction

To serve diverse classrooms, English teacher training should include:

- Strategies for inclusive education, especially for learners with disabilities or language difficulties.
- Methods for differentiated instruction based on learner proficiency levels.
- Sensitivity to gender, caste, and socio-economic factors in content delivery.

Assessment Literacy

Future teachers must be assessment-literate and capable of:

- Creating rubrics for productive skills (speaking, writing).
- Using formative tools like portfolios, peer assessment, and teacher feedback.
- Analysing student data to inform instruction and remediate learning gaps.

Continuous Professional Development and In-Service Training

NEP 2020 mandates a structured system of Continuous Professional Development (CPD). For English educators, CPD may include:

- Annual training in innovative ELT practices.
- Short courses in areas like phonetics, creative writing, digital literacy, and inclusive pedagogy.
- Participation in professional networks, both national (NCERT, NIOS) and international (British Council, TESOL).

Challenges in Implementation

Despite the policy's transformative goals, several challenges persist:

- **Infrastructure Gaps:** Many schools, especially in rural areas, lack digital tools and trained faculty.
- **Resistance to Pedagogical Change:** Teachers entrenched in traditional methods may find new practices overwhelming.
- **Shortage of ELT Specialists:** There is a national need for qualified mentors and trainers in English education.
- **Translating Policy to Practice:** Effective execution of reforms requires monitoring, support, and contextual adaptation.

Opportunities and Future Directions

NEP 2020 opens doors for innovation and academic renewal:

- English curricula can be redesigned to promote critical literacy, creativity, and intercultural communication.
- Bilingual and multimodal teaching materials rooted in local contexts can enrich classroom engagement.
- Teacher-led action research and school-based innovations can contribute to context-specific ELT strategies.
- A new generation of reflective, research-informed, and adaptable English educators can emerge if NEP 2020 is implemented with integrity.

Conclusion

NEP 2020 offers a holistic, future-oriented vision for transforming English teaching at the secondary and higher secondary levels in India. Its emphasis on integrated teacher preparation, learner-centric pedagogy, and continuous professional development addresses many of the systemic issues that have hindered effective English instruction. If supported by adequate infrastructure, training, and policy coherence, the NEP can elevate the quality and relevance of English education, helping students gain not only linguistic proficiency but also confidence, critical thinking, and global readiness.

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Integration of Indian Knowledge System in Science Subjects

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Abstract

The Bhartiya way is sustainable and strives for the welfare of all. It is important that we regain the comprehensive knowledge system of our heritage and demonstrate the 'Indian way' of doing things to the world. This requires training generations of scholars who will demonstrate and exemplify to the world a way of life so unique and peculiar to our great civilization. The NEP, 2020 recognizes this rich heritage of ancient and eternal Indian knowledge and thought as a guiding principle. The Indian Knowledge Systems comprise of Jnan, Vignan, and Jeevan Darshan that have evolved out of experience, observation, experimentation, and rigorous analysis. This tradition of validating and putting into practice has impacted our education, arts, administration, law, justice, health, manufacturing, and commerce and different science concepts like physics, astronomy, medicine, metallurgy, sound, magnetism, astrology and many more. "Knowledge of India" in this sense includes knowledge from ancient India and, its successes and challenges, and a sense of India's future aspirations specific to education, health, environment and indeed all aspects of life. the Indian knowledge system has not only contributed to significant advancements in mathematics, astronomy, and medicine, with scholars like Aryabhatta and Sushruta laying foundational work in their respective fields but also offers alternative solutions to global issues such as sustainability and ethical concerns, promoting a balanced and harmonious future. There is a growing movement to preserve and decolonize IKS, ensuring its integration into modern education and global discourse while maintaining its authenticity and cultural significance.

Keywords : IKS, Science Subject, Atomic Theory, Medical Science, Chemistry and Metallurgy

INTRODUCTION

The National Education Policy 2020 envisions a massive revolution in India's education sector, underpinned by Indian Knowledge System. India possesses an immense wealth of knowledge, with numerous manuscripts yet to be explored. Traditionally Indian Knowledge, described as the 14 Vidya (4 Veda, 4 Upveda, 6 Vedanga) and 64 Kala which encompasses philosophy, practical education, arts, skills, craftsmanship, agriculture, health and science. These traditions will be studied,

added and integrated into modern life, heralding transformative changes in every sphere.

The Indian knowledge systems comprise of Jnan, Vignan and Jeevan Darshan that have evolved out of experience, observation, experimentation, and rigorous analysis. This tradition of validating and experimenting and practising has impacted in education. So “Knowledge of India” in this sense includes knowledge from ancient India and its success and a sense of India’s future aspirations specific to education, health, environment and indeed various aspects of life. (Sunita Acharya 2024)

In the view of Kautilya, Education should focus at three outcomes such as, Vidya- Creation of new Knowledge, Vivek -Wisdom to use the right knowledge in right time and place for right purpose, and Vichashaknata – the skill set to get the proper results of knowledge in real life. These results are possible only when the education system is properly balanced with the integration of knowledge and skill in an appropriate manner. In today’s education, organization of knowledge content “what to know” has taken over the best of knowledge seeking “inquiry” that is “how to know”. The entire Indian Knowledge System has always focused on “how” rather “what”. Ancient Indian education, exemplified by the Gurukul system, emphasized holistic learning through oral traditions, critical thinking, and a strong teacher-student relationship. This system integrated intellectual, spiritual, and moral education, influencing modern pedagogical debates. Ancient universities like Nalanda and Takshashila were centers of multidisciplinary learning, covering subjects from philosophy to sciences, and have inspired modern educational frameworks like India's National Education Policy 2020. The National Education Policy (NEP), as enacted in 2020, emphasizes the inclusion of IKS into curriculums at all levels of education, in line with this, the National Credit Framework (NCF) has made it possible for students to earn credit in courses relating to Ancient Indian Sciences and arts. Under University Grants Commission (UGC) guidelines, it is advised that 5 per cent of a student's total credits should be in IKS courses at the undergraduate and postgraduate levels. The UGC aims to train 1.5 million teachers in IKS by 2025, and has launched an online IKS MOOC course.

Fundamentals of Indian Knowledge System in various science subjects.

ATOMIC THEORY IN PHYSICS

Acharya Kanada, also known as Kashyapa, an ancient Indian natural scientist and philosopher, formulated the theory of atoms 2500 years before John Dalton’s discovery. He founded the Vaisheshika school of Indian philosophy that epitomized

the earliest Indian physics. He used this to explain the creation and existence of the universe by proposing an atomistic theory, applying logic and realism which made his school one of the earliest known systematic realist ontology in human history. Kanada believed that the atom was eternal and has the tendency to bind with other atoms. Vaisheshikaatomists posited the four elemental atom types.

The union of two atoms forms a double or binary molecule, called “Dwinuka”. According to theory proposed by Kanada, Dwinuka would have similar properties as of the original parmanu (atoms). He also stated that the combinations of different type of atoms result in a non-identical molecule that could chemically change a component in the presence of specific factors such as heat — for example, change in color of utensils made of mud when they are heated. Kanada’s book, called *Vaisheshik Darshan* (also called *Kannada sutras*), captured his atomic theory which states the following:

- Everything can be partitioned
- Subdivision leads to creation of parmanu (atom) after a while
- Parmanu is indivisible, that is, it cannot be divided further,
- It cannot be seen through naked eye
- Subsection of any particle has an end and cannot be carried infinitely.
- Atom is indestructible, and is the foundation for all material existence
- Parmanu has a specific property which is same as the class of substance to which it belongs
- It Atoms can be combined in different ways to produce chemical changes by heating them or using other measures.
- Parmanu or atom can have two states — state of motion and state of absolute rest.

Medicinal Chemistry: Ayurvedic books go into great detail about making medicines out of natural ingredients. These methods include extraction, purification, and formulation processes that are similar to those used in contemporary medicinal chemistry and pharmaceutical industries.

Chemical Procedures: Detailed procedures for the distillation, sublimation, alloying, and purifying of substances are described in Indian scriptures, including those ascribed to Nagarjuna and others in the *Rasa-shastra* school. The development of useful chemical techniques was aided by these techniques.

MEDICAL SCIENCE

The original date of the *Charaka Samhita* is not known but some estimate its composition to have occurred early in the 4th century BCE ([Porter, 1998](#))

The extant text has eight *sthāna* (books), totalling 120 chapters. The text includes a table of contents embedded in its verses, stating the names and describing the nature of the eight books, followed by a listing of the 120 chapters. These eight books are

- *Sutra Sthana* (General principles) - 30 chapters deal with general principles, philosophy, definitions, prevention through healthy living, and the goals of the text.^[30] It is divided into quadruplets of 7, making it 28 with 2 concluding chapters.
- *NidanaSthana* (Pathology) - 8 chapters on causes of diseases.
- *VimanaSthana* (Specific determination) 8 chapters contain training of a physician, ethics of medical practice, pathology, diet and nourishment, taste of medicines.
- *ŚariraSthana* (Anatomy) - 8 chapters describe embryology & anatomy of a human body (with a section on other living beings).
- *IndriyaSthana* (Sensory organ based prognosis) - 12 chapters elaborate on diagnosis & prognosis, mostly based on sensory response of the patient.
- *CikitsaSthana* (Therapeutics) - 30 chapters deal with medicines and treatment of diseases.
- *KalpaSthana* (Pharmaceutics and toxicology) - 12 chapters describe pharmacy, the preparation and dosage of medicine, signs of their abuse, and dealing with poisons.
- *Siddhi Sthana* (Success in treatment) - 12 chapters describe signs of cure, hygiene and healthier living.

Seventeen chapters of *Cikitsāsthāna* and complete *Kalpasthāna* and *Siddhi sthāna* were added later by Dṛdhabala. The text starts with *Sūtrasthāna* which deals with fundamentals and basic principles of Ayurveda practice.

SURGERY

Susrutasamhita *SusrutaSamhita*, has not survived and its only existence is in the form of revisions and copies ([Ruthkow, 1961](#)). Late Vedic hymns ascribed to Susruta suggested that he must have flourished during the latter part of the Vedic age, which would place him around 1000 BCE.

Despite his erroneous accounts of the skeleton, Susruta offered an in-depth understanding of bones, muscles, joints and vessels that far exceeded the knowledge of the time ([Persaud, 1997](#)).

The *Sutrasthana* deals with basic medical science and pharmacology; *Nidana*, addresses disease processes; *Chikitsasthanam* is the bulk of the text, 34 chapters on

surgical procedures and post-operative management; and the *Kalpasthanam* is composed of eight chapters on toxicology.

CHEMISTRY AND METALLURGY

- The ancient system of alchemy “rasa-shastra” deals with study of metals, minerals, and chemical processes. Alchemist aimed to transmute base metals into gold and use in medicines. Ayurveda books go into great details about making medicines out of natural ingredients. These methods include extraction, purification and formulation processes those are similar to those used in contemporary medicinal chemistry and pharmaceutical industries.

Indian metallurgies worked with variety of metals like copper, bronze, iron etc. they developed different alloys with specific properties for different applications.

- Iron use: evidences of early iron use is found in archeological sites as in chotanagpur plateau, (1200BC).
- Iron pillar of Delhi: famous example of iron working erected during Gupta period (4th and 5th century). Iron made of high purity is renowned for its resistance to rust and corrosion.

Different extracting and processing techniques like

- Smelting: which involves heating ores in a furnace to extract metals.
- Casting: lost wax casting technique used to create bronze sculptures and tools which we praise even today for their magnificent making.
- Forging and hammering: process involved heating the metal and hammering into desired shape that was commonly used for creating weapons, tools and ornaments.
- Jewelry and ornaments: techniques of granulation, filigree and inlay work were employed to create intricate and decorative pieces.

PERFUME MAKING

Varahmihira the sixth century’s scientist write the book “Bruhatsamhita”, which has chapters related to methodology of making perfumes about diffuse oil from plant extracts. It is believed to have its roots in Indus valley, the secondary metabolites are distilled, the apparatus is terra-cotta distillation machine made by porous material, (3000BC) the essential oils were extracted using this process and India was world leader in perfume production.

MAGNETISM

The ancient Indian text SushrutaSamhita was the first to describe the use of lodestone (i.e. magnetite) as a surgical tool used to remove arrow heads embedded in a person's body. This is the earliest account of employing magnetism in human health care.

AGRICULTURE

- **Integral to Vedic Society:** Agriculture was deeply intertwined with Vedic society, influencing its rituals, traditions, and the overall worldview of the early Indo-Aryans.
- **Divine Platform:** The Rig-Veda places agriculture on a divine platform, with agricultural practices organized around rituals and offerings.
- **Crops:** The Rig-Veda mentions various crops, including barley (yava), rice (vrihi), and other grains.
- **Irrigation:** The text mentions the use of rainwater for irrigation, with small streams formed from rainfall and water lifted using buckets (Droni).
- **River Water:** The Rig-Veda highlights the importance of rivers like the Sindhu (Indus) and Saraswati as sources of water for irrigation and agriculture. The step wells in Rajasthan and Gujarat are good examples of water shed system. The Rajasthan people were able to squeeze water from gypsum. The ahayn and pine system in Bihar is also a good example of water management.
- **Animal Husbandry:** Cattle-rearing was a prominent occupation, and the cow was seen as a source of wealth and economic prosperity.
- **Ploughing:** The Atharvaveda associates Pr̥thīVainya with the origin of ploughing.
- **Manuring:** The Rig-Veda mentions the use of cow dung as manure. **Harvesting and Threshing:** The text also contains references to different stages of cultivation, including ploughing, sowing, harvesting, and threshing.

SOUND

The Nelliappar temples from Pandya rulers in south has a cluster of 48 pillars were carved from a single stone, and they surround central pillar 161 pillars in total that makes a musical sound, surrounding pillar vibrate when one of them is tapped. This is amazing example of sound engineering, this is possible only when one has strong understanding of amplitude, frequency and all. Many of the musical instruments are made which are on verge of extinct but are great examples of knowledge of sound and its components.

ARCHITECTURE

The sun dial at konark from Bronze Age, they used bones, stones, bamboo, clay, the specialty is it gives the exact time based on the sunrays that fall on it. This is possible only when our ancestors had exact idea of planetary situation and mathematics.

Lost wax casting of idols was very famous and many are made of “panch-loha” which are combinations of five metals like, lead, silver, gold, copper and zinc. But these idols have survived till date which shows intelligence in making them the ratio of each metal so that they don’t disintegrate.

ASTROLOGY

Our rishis understood where mankind stood in relation to the Earth and the universe and offered wisdom to ensure we, as a species, did not lose that connection. The most evident of the tools devised by the rishis is jyotish, the Hindu astrology ‘science’. The Hindu rishis knew of the planets affecting life and sought to understand this effect on the earth, and on our lives. Apart from astrology, they also devised vastushastra, the traditional Hindu system of design based on directional alignments. Vastushastra focuses on invisible and constant relation between all the five elements, earth, air, fire, water and space. It prescribes desirable characteristics for sites and buildings based on flow of energy (prana).

The magnetic field of Earth reflects how the planets are moving around the sun and even how Earth is moving around the sun. And as the moon goes round Earth it affects the tides not only in the ocean but in the magnetosphere [Earth's magnetic field]. Earth and other planets cause a very complex tune to be played on the magnetic field of Earth. The symphony, of course, is made up of tunes. The astrologer, if he is truly adept at what he does, would be able to identify these tunes separately and see how they affect an individual’s life at any given time, now and in the future, after working out the placement of planets.

SPACE SCIENCE

The Rig Veda is one of the oldest pieces of Indian literature. Rig Veda 1-64-11 & 48 describes time as a wheel with 12 parts and 360 spokes (days), with a remainder of 5, making reference to the solar calendar.(Siddhart)

Indian astronomy flowered in the 5th–6th century, with Aryabhata, whose work, Aryabhatiya, represented the pinnacle of astronomical knowledge at the time. The Aryabhatiya is composed of four sections, covering topics such as units of time, methods for determining the positions of planets, the cause of day and night, and

several other cosmological concepts. The heliocentric theory, eclipse and sidereal periods were introduced and contributed significantly to understand celestial cycles.

- Varahamihira (505-587 CE) his work “panchasiddhantika” summarized astronomical knowledge giving practical applications such as predicting planetary conjunctions, celestial events etc.
- Vedanga Jyotisha is another of the earliest known Indian texts on astronomy, it includes the details about the Sun, Moon, nakshatras, lunisolar calendar. (Bhushan)
- Brahmagupta (598–668 CE): “Brāhmasphuṭasiddhānta” also calculated the instantaneous motion of a planet, gave correct equations for parallax, and some information related to the computation of eclipses (Sharma 2008)
- Bhāskara I (629 CE): Astronomical insights shown in “Mahābhāskariya” writes 'Planetary longitudes, heliacal rising and setting of the planets, conjunctions among the planets and stars, solar and lunar eclipses, and the phases of the Moon are among the topics Bhāskara discusses in his astronomical treatises

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Fostering a Growth Mindset in Educators for Better Learning Outcomes

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Abstract

In the 21st century, top competencies for educators include critical thinking, digital literacy, mindfulness, creativity, continuous learning, problem-solving, leadership and management skills, stress management, time management, and ethical decision-making. To effectively develop and apply these skills, teachers must first believe in their own intelligence, abilities, and potential for growth. This begins with fostering a growth mindset—the belief that skills and intelligence are malleable and can be developed through effort, learning, and perseverance.

They open the door to novel teaching strategies and welcome challenges as learning opportunities. These teachers persist, constantly seeking professional development opportunities, adapt to shifting educational environments, and develop that same mindset in their students. Growth mindset furthermore enables the teacher to cope with stress wisely, being that challenges are embraced as learning experiences instead of failures or threats to their abilities. By incorporating growth mindset into teacher training and professional development, the schools could establish an environment where educators are ever-evolving, fostering better teaching practices and improved students' outcomes. Further, fostering a growth mindset is a collaborative mandate for developing educational contexts. Overcoming a fixed mindset requires shifting perspectives, embracing challenges, and understanding that intelligence and skills can grow with effort, persistence, and the right strategies. By promoting a growth mindset, teachers and students can unlock greater potential, confidence, and lifelong learning success

This chapter explores the benefits of a growth mindset in teachers, the impact it creates in their teaching journey as well as in students' learning outcomes. The chapter also highlights a few strategies to develop a growth mindset in teachers.

Key words: *Mindset, fixed mindset, growth mindset, resilience, competencies, healthy risk taking*

Introduction

Teachers' jobs are evolving day by day. In today's educational environment, teachers' responsibilities extend beyond simply lecturing and taking notes; they also need to develop the skills necessary to better manage their classrooms and give their students cutting-edge instruction and learning opportunities (Pathak, 2024).

The most advanced technologies and innovations should be used in teacher training because these are the people who are going to prepare the future generation. Unless and until these educators use and understand technology how can we expect them to teach about technologies to the future generation. The curriculum and the course work for most of the teacher training is old and, in most cases, not relevant. We often forget that these teachers need to be prepared for teaching Gen Z, alpha and beta generations. But how often will the curriculum or course work be reframed? Everyday there are changes in the field of education. How do we inculcate all of these changes or how often can we accommodate and update these changes?

As a part of the teaching profession, every teacher should be committed towards their continued learning. Many times teachers believe that earning a degree is sufficient for teaching, ignoring the part of continuing their learning and development. Unless and until the school, management or government does not force to take up development programs teachers don't participate. This is where having a right mindset is important. Having a right mindset does not only solve the problem of teachers continuing the development programmes but also brings in changes in the overall personality and outlook of a teacher. Mindset ignites the intrinsic motivation among the teachers which results in better commitment of teachers towards their profession.

Mindset:

The concept of mindset was given by Carol Dweck. Mindset is the way we perceive our abilities, intelligence, capacities etc. This seven-letter word is a crucial part in deciding how we see ourselves. Further the mindset is classified into two types: fixed mindset and growth mindset. Having the right mindset helps people in achieving their full potential.

People with a fixed mindset believe that capacities and abilities are fixed and one cannot do anything about it. Whereas people with a growth mindset believe in

malleability. They believe intelligence, abilities and talents are malleable and with the right amount of hard work and effort one can achieve their desired goals. Research on how people think, feel, and react to failure and difficult situations is summed up by the mindset framework. People with a "fixed mindset," or the belief that intelligence and ability are essentially unchangeable, react to failure by withdrawing, disengaging, or continuing to use the same set of tactics even when they have been shown to be ineffective in the past (*Growth Mindset | Teaching + Learning Lab*, n.d.).

Research has examined these two types of mindsets and discovered that such lay beliefs can predict a range of personal outcomes. Mindset is one of these spectrums of distinct perspectives: the idea that people hold differing beliefs regarding the malleability of human attributes. At one extreme is the view that these attributes, like intelligence or personality, can be changed through effort and determination, while at the other extreme is the view that these attributes are innate and remain fixed over time (*Mindset Theory - the Decision Lab*, n.d.)

The important thing to remember is that these mindsets greatly influence how we view success and failure. People with fixed mindsets fear failure because they believe it detracts from who they are, whereas people with growth mindsets welcome it as a chance to grow and learn (Heggart, 2015).

Growth and Fixed mindset:

People who believe that with the right amount of effort and hard work, they can develop their abilities and skills are people with a growth mindset. These people do not see challenges as a threat but as growth opportunities. They not only seek challenges but thrive in them. One of the strongest qualities of a person with a growth mindset is that they are resilient to failures. They see failures as a lesson to learn from and to improve their skills.

People with a fixed mindset believe in innate abilities and talents. They see intelligence as a fixed quality and believe that there is little or nothing that they can do about it. Unlike people with a growth mindset, they are not resilient. According to Dweck's research, one of the most fundamental beliefs we hold about ourselves is related to how we perceive and inhabit our perceived personalities (Popova, 2021).

People with a growth mindset are not threatened by other people's success whereas people with a fixed mindset see these successes as a threat to their abilities. People

with a growth mindset don't let stereotypes affect their performance; instead, they take the edge off of stereotypes and become more resilient. They don't think that people are always inferior, and if they fall behind, they'll put in more effort, ask for assistance, and try to catch up (Dweck, 2006).

According to research, students who have a growth mindset are more likely to put in the effort and persevere through challenging assignments because they believe that their intelligence and skills can be developed through hard work and dedication (Ryan, 2024).

In contrast, people with a fixed mindset may actually be more likely to give up when faced with challenges because they believe that their abilities are fixed and cannot be improved. Research has shown that people with a growth mindset are more resilient, persistent, and motivated; they embrace challenges and see them as opportunities to learn and grow rather than as threats to their self-worth (Ryan, 2024).

In an educational setting, a fixed mindset can limit both teachers' and students' performances. Believing their abilities to be fixed will result in them not reaching their full potential. Fixed mindset becomes a barrier to learning for both teachers and students. Teachers who believe in innate abilities and fixed intelligence, will not value the efforts of children. They may resist new teaching strategies, would avoid feedback about their lessons and may feel professional development programs are a waste of time. It becomes challenging to work with teachers with a fixed mindset as they resist changes, are not resilient and do not welcome feedback. People with a fixed mindset often label themselves. Teachers with a fixed mindset will label students as well.

- **Benefits of having a growth mindset**

1. ***Resilient***

Individuals with a growth mindset develop resilience, which helps them face obstacles and setbacks. Such teachers see task failures as possibilities for improvement rather than personal shortcomings. These are those teachers who are ready to seek ways to enhance their strategies and modify their practice. Such teachers provide opportunities for feedback-positive or critical-and-respect constructive criticism as an important tool for their developing professionalism. Such resilience allows the teachers to adapt, persist, and work towards bettering their results in their classrooms.

2. *Thrives in challenges*

Teachers come across a lot of challenges on a daily basis. Every Time they enter a class there is something new and challenging for them and sometimes they get overwhelmed by these changes. When faced with difficult students, curriculum changes, or unexpected setbacks, they remain adaptable and solution-oriented. Instead of feeling threatened by change, they embrace it as an opportunity to learn, adapt, and enhance their teaching practices. They reflect on their experiences, seek new strategies, and persist with determination. This mindset empowers them to approach difficulties with confidence and resilience, ultimately fostering both personal and professional growth. By facing challenges, they not only grow in their field but motivates students to develop perseverance and love for lifelong learning.

3. *Open to feedback*

Teachers are scared of observations by senior faculties or principals. The reason for the same is negative feedback. Teachers take feedback as a flaw in their teaching. With a growth mindset teachers consider the feedback as a stepping stone towards their career's development. The feedback is seen as a tool to grow rather than to criticise. They take the feedback and work on it. Eventually improving the quality of learning. By modelling a positive attitude towards feedback they motivate students to accept feedback positively.

4. *Values efforts*

People with a growth mindset believe in efforts over innate abilities. They believe that whatever skills they need to develop can be developed. This perspective is crucial in the realm of education, as changes occur daily, necessitating that educators adjust to these developments. Teachers understand that talent alone is not enough, persistence and consistency is also required. Thus teachers do not hold back in trying new things as they believe, everything can be learned.

5. *Love for learning*

Teachers are learners. Learning is a continuous process for the teachers. In general scenarios teachers have to be forced to attend seminars and workshops. When a new concept or method is introduced for teaching teachers

sees them as a challenge to their own skills. Teachers with a growth mindset continuously seek new knowledge, explore innovative teaching methods, and remain open to new perspectives. With a growth mindset learning comes naturally as they see learning as a part of development and not as lacking in their abilities.

6. *Growth mindset language*

A teacher with a growth mindset understands the power of language in shaping students' attitudes toward learning and challenges. By using positive and encouraging words, they create a supportive environment where students feel safe to take risks, make mistakes, and persist through difficulties. Instead of focusing on fixed abilities, they emphasize effort, strategies, and continuous improvement. Phrases like “You’re not there yet, but you’re making progress” or “Mistakes help us grow” reinforce the idea that intelligence and skills can be developed through effort and perseverance. This approach not only boosts students' confidence but also nurtures resilience, helping them view challenges as opportunities rather than obstacles. Over time, such language fosters a love for learning, as students become more motivated to explore new ideas, ask questions, and push beyond their comfort zones. By modelling a growth mindset in their words and actions, teachers inspire students to develop the same belief in their own potential.

7. *Inculcate growth mindset in students*

Kids learn by observing a lot, therefore they tend to reflect the behaviours, attitudes, and beliefs from the adults whom they spend much time with. In the context of the class, teachers set the students' mindsets because one of the best ways a teacher can set a growth mindset is by simply modelling it; when teachers, day in, day out model perseverance, adaptation, and even a positive approach to challenges then the students more likely do it in learning as well.

8. *Intrinsic motivation*

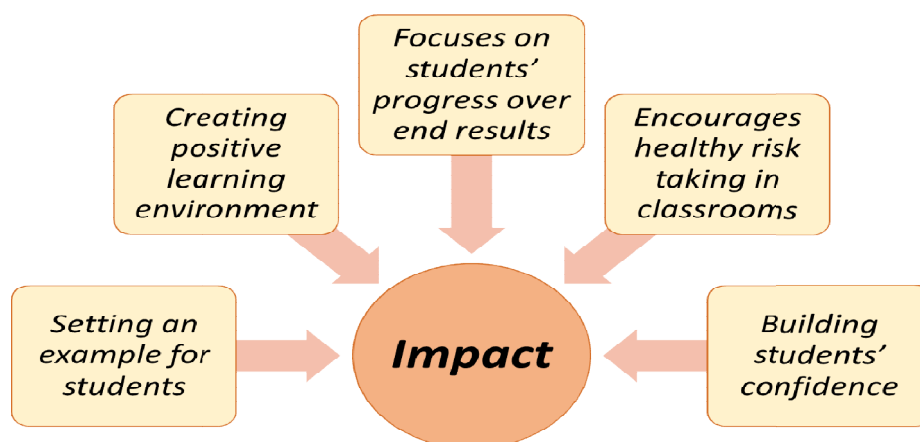
There are two types of motivation , intrinsic and extrinsic. While extrinsic or external motivation is dependent on external factors like salaries, benefits. Intrinsic motivation is within and is not affected by external factors. Growth mindset thus reduces or removes their dependence on external factors. Growth

mindset helps in developing intrinsic motivation in teachers. Teachers with a growth mindset are driven by passion for teaching. They believe in consistency and effort. Therefore putting in efforts to improve the learning experience and outcomes of the students. This intrinsic motivation also helps the teachers to stay focused and resilient throughout the difficult situations.

9. *Accept changes*

It's often quoted that it is difficult to introduce new technology or methods to senior teachers as they are not ready to accept changes. They prefer working with the old method and styles. Growth mindset changes this as they see changes are a way to learn. Teachers with a growth mindset understand that changes are an opportunity to learn, grow, innovation and improvement. Teachers instead of resisting new ideas and changes, they embrace them and try to thrive in it. Eventually creating a better learning environment and experience for students.

● **Impact of growth mindset teachers on students learning**



Impact of growth mindset teachers on students learning

Figure-1

1. *Setting an example for students*

Developing a growth mindset is equally important as developing critical thinking and problem solving skills. One of the techniques to cultivate a growth mindset in students is by setting examples for them. When a teacher has a growth mindset, it will reflect in their actions like valuing efforts over

innate abilities, motivating students to take risks, providing constructive feedback etc, thus creating a safe environment for students which will eventually develop a growth mindset among students.

2. *Creating positive learning environment*

Teachers with a growth mindset creates a positive learning environment by encouraging healthy risk taking, fostering a culture of encouragement, resilience and working towards continuous improvement. As they believe in effort and hard work, they motivate students to embrace challenges, to learn from mistakes and create a safe environment for students to learn and experiment. Teachers with a growth mindset value progress and so provide students with constructive feedback. This develops confidence and love for learning among students.

3. *Focuses on students' progress over end results*

Growth mindset focuses on efforts over end results. People who have a growth mindset believe that with the right amount of effort one can achieve success. Teachers with a growth mindset highlight students' efforts over innate abilities. They motivate students to keep working and moving forward.

4. *Encourages healthy risk taking in classrooms*

Healthy risk taking is when students try out something new or challenging. This helps in building resilience and confidence in them. It is called healthy risk because it develops a positive attitude in students. Teachers with a growth mindset not only encourage healthy risk taking in students, but also celebrate it as a key aspect of learning. Teachers believe taking risks will allow students to develop resilience and better understanding of new concepts.

5. *Building students' confidence*

Students often are low on confidence because they fear the end result. A teacher with a growth mindset makes students believe that with effort and hard work they can develop their abilities. Teachers also help in making students understand the importance of learning from mistakes. Students thus are encouraged to take healthy risks and eventually help them develop confidence. They also develop confidence as they are focused on their growth and performances rather than comparing with others' results.

A teacher with a growth mindset will not only develop confidence, resilience and healthy risk taking but also equip them with the skills that they need to navigate the challenges that they face inside and outside the classroom.

Table-1
Comparison between fixed mindset teachers and growth mindset teachers

Aspects	Teachers with Fixed Mindset	Teachers with Growth Mindset
View on Intelligence & Abilities	Believe teaching ability is innate and cannot change.	Believe skills and intelligence can be developed through effort.
Response to Challenges	Avoid challenges to prevent failure.	Embrace challenges as opportunities to grow.
Feedback	Feel defensive and take feedback personally.	See feedback as a tool for improvement.
Approach to Student Potential	Believe students have fixed abilities and can't improve much.	Believe all students can improve with effort and the right strategies.
Reaction to Failure	View failure as a reflection of their incompetence.	View failure as a learning experience.
Effort & Persistence	Believing effort won't make a difference if talent is lacking.	Value effort and persistence as keys to success
Attitude Towards Change	Resist new teaching strategies and prefer traditional methods.	Are open to new ideas and continuously seek improvement.
Collaboration with Colleagues	Work in isolation and may see others as competition.	Share ideas, seek feedback, and collaborate with peers.
Impact on Students	May unintentionally discourage students from trying harder.	Inspire students to adopt a growth mindset and develop resilience.

- **Strategies to foster growth mindset among teachers**

- 1. Modelling growth mindset**

The most obvious way to apply a growth mindset to teacher professional development is through modelling. According to Jackie Gerstein, who has led several professional development courses aimed at teaching teachers how to model a growth mindset among students, one of her main tenets is encouraging teachers to see themselves as learners. Teachers, like the students they teach, can learn to develop a growth mindset, but this requires careful planning by school management (Heggart, 2015).

- 2. Giving opportunities for growth**

Teachers are frequently denied opportunities to develop. As a result, they lose motivation and adopt a rigid mindset. Because the school does not provide them with the option to teach in other grades, teachers are frequently locked in one grade. Teachers get a fixed mindset as a result. Teachers at schools that give students the chance to try out different grades, assume leadership positions, etc., don't have a relaxed attitude. Schools can offer workshops, mentorship programs, and leadership roles that encourage teachers to explore new teaching strategies and expand their skills. Encouraging regular self-reflection and self-assessment also plays a crucial role, helping educators identify areas for improvement and celebrate progress.

- 3. Space and Time for Learning**

Not surprisingly, one of the most common issues that lead to teacher stress and burnout is excessive workload. After all, teachers are not only responsible for teaching, but they may also have had to spend time on administrative work and so professional learning and development is placed on the lowest priority, if at all. As a result, studies show, more teachers tend to develop a negative attitude towards such programs. On the other hand, teachers who are truly dedicated to learning and are given opportunities to learn without being overly burdened with workload tend to develop a love for learning. This alone breaks the cycle of negative attitude towards strategies that support growth and development in the classroom.

4. Constructive Feedback

Their reports of class observation are usually very typical in that they state the successes and failures of the teacher without proffering any useful instructions on how the teacher can improve. Constructive feedback is not only meant for refining lesson planning and teaching, but when given in the most thoughtful manner can lead to better learning for students. Once outcomes are improved, it further increases teachers' motivation and professional contentment, thus creating a cycle of improvement and growth. Constructive feedback should be used as a tool for their growth rather than a way to criticise the teachers. Feedback should also highlight the strengths and efforts of the teacher.

5. Reflection

"Sometimes one student has a bad day, but when the lesson goes poorly for the entire class, it's probably something I did wrong. I have learned a lot from my hardest students and my biggest lesson plan failures, but only because I think back on what went wrong. I would never learn from experience if I wrote those students and lesson plans off as not my fault (Gil, 2016)." reflecting on the lessons taken will help a teacher identify the weak points in their lessons. This will help them to improve their lessons resulting in better learning outcomes for students.

Conclusion

Developing a growth mindset among teachers is crucial for improved learning outcomes and student success. When teachers have a belief that intelligence and talents are capable of being developed through effort and commitment, they give rise to a good, motivational, and energetic learning environment. This mindset allows them to keep improving their instructional strategies, adopt new innovative strategies, and respond to the different needs of students.

By fostering perseverance, positive feedback, and resilience, teachers encourage learners to accept challenges, perceive failure as an opportunity to learn, and build confidence in themselves. Growth mindset also encourages collaboration and creates a safe environment in which students are willing to share ideas, ask questions, and academically risk. It also keeps teachers themselves receptive to ongoing professional growth, lifelong learning, and changing instructional practices.

Ultimately, as teachers develop a growth mindset, they not only improve academic outcomes but also promote creativity, problem-solving abilities, and a desire for lifelong learning. This produces a more comprehensive, flexible, and effective educational system, preparing students to encounter real-world obstacles with confidence and resilience.

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Promoting Multilingualism: Enhancing Knowledge Acquisition and Communication in a Globalized World

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Abstract

In today's interconnected world, the promotion of multilingualism has emerged as a crucial factor in facilitating knowledge acquisition and communication on a global scale. This paper explores the multifaceted benefits of multilingualism in enhancing cognitive abilities, fostering cross-cultural understanding, and promoting effective communication. Drawing on existing research and case studies, it examines the role of multilingualism in education, workplace settings, and international cooperation. Furthermore, it discusses the challenges and opportunities associated with promoting multilingualism in diverse socio-cultural contexts and suggest strategies for policymakers, educators, and individuals to embrace and leverage multilingualism for mutual enrichment and global collaboration. The present research article described the diverse linguistic landscape of India and the interconnectedness of the global community, the NEP 2020 underscores the need to harness the benefits of multilingualism for holistic learning and inclusive development.

Keywords: Multilingualism, Globalized World, NEP-2020, Socio-Cultural Context

Introduction

The National Education Policy (NEP) 2020 of India marks a significant shift in the country's approach to education, emphasizing the importance of promoting multilingualism to enhance knowledge acquisition and communication in a globalized world. Recognizing the diverse linguistic landscape of India and the interconnectedness of the global community, the NEP 2020 underscores the need to harness the benefits of multilingualism for holistic learning and inclusive development.

Linguistic Diversity in India:

India is home to a rich tapestry of languages, with over 19,500 languages and dialects spoken across the country. This linguistic diversity reflects India's cultural heritage and societal pluralism. However, it also presents unique challenges in education, where language plays a pivotal role in shaping learning outcomes and fostering inclusive classrooms. Efforts to preserve and promote linguistic diversity include policies that encourage the use of regional languages in education, media, and administration. The National Education Policy (NEP) 2020 aims to support multilingual education and the development of regional languages. Linguistic diversity in India has a significant impact on the educational landscape, and the approach to education often reflects the country's multilingual nature. As outlined in the National Education Policy (NEP) 2020, the Three-Language Formula requires students to learn three languages: one from the national level, one from the regional language, and a third language which could be another regional language or a foreign language. This formula aims to promote multilingualism and respect for linguistic diversity.

NEP 2020 and Multilingual Education:

The NEP 2020 recognizes the importance of multilingualism in education and advocates for a flexible and inclusive language policy that promotes proficiency in multiple languages. One of the key principles of the NEP is the promotion of multilingualism as a foundational pillar of education, from early childhood to higher education. The policy encourages the use of mother tongue or local language as the medium of instruction in primary education, while also promoting the learning of other Indian languages and English.

NEP 2020 emphasizes the importance of teaching in mother tongues and regional languages, particularly in the early years of education. This approach helps improve comprehension and learning outcomes by using languages that students are already familiar with.

Medium of Instruction: Education in India is conducted in multiple languages. The medium of instruction varies by state and educational institutions, often reflecting the region's predominant languages. For instance, in states like Tamil Nadu and Karnataka, education is primarily in Tamil and Kannada, respectively, while in states like Uttar Pradesh and Bihar, Hindi is widely used.

Textbooks and Learning Materials: Efforts are made to develop textbooks and educational resources in various languages to cater to students from different linguistic backgrounds. This helps ensure that educational materials are accessible and relevant to all students.

Language Preservation and Promotion: The policy encourages the preservation and promotion of regional languages by integrating them into the curriculum. This includes supporting literature, culture, and heritage associated with different languages. Language Preservation and Promotion: The policy encourages the preservation and promotion of regional languages by integrating them into the curriculum. This includes supporting literature, culture, and heritage associated with different languages.

Challenges and Opportunities: The diversity of languages presents challenges in standardizing educational content and ensuring equitable access to quality education. However, it also offers opportunities for enriched learning experiences and the preservation of linguistic and cultural heritage.

Overall, India's educational system strives to accommodate its linguistic diversity through policies that support multilingual education and the use of regional languages, while also addressing the challenges that come with such a diverse linguistic landscape.

Benefits of Multilingualism in Education:

Research has consistently shown that multilingualism offers cognitive, academic, and socio-cultural benefits to learners. By providing instruction in the mother tongue or local language, students can better comprehend complex concepts, develop strong literacy skills, and maintain a strong connection to their cultural identity. Furthermore, exposure to multiple languages from an early age enhances linguistic flexibility, cognitive abilities, and cross-cultural understanding.

Cognitive Development: Learning multiple languages enhances cognitive abilities such as problem-solving, multitasking, and memory.

Cultural Awareness: Exposure to different languages fosters an understanding and appreciation of diverse cultures, promoting global citizenship.

Improved Academic Performance: Multilingual students often perform better in standardized tests and academic tasks due to enhanced cognitive flexibility and problem-solving skills.

Enhanced Communication Skills: Proficiency in multiple languages improves overall communication skills and enables students to connect with a broader range of people.

Career Opportunities: Multilingual individuals have a competitive edge in the global job market, as they can work in diverse environments and roles.

Social Skills: Multilingual students often develop better social skills and adaptability, as they navigate different linguistic and cultural contexts.

Greater Empathy: Understanding and speaking multiple languages can increase empathy and sensitivity towards others' perspectives and experiences.

These benefits contribute to a more rounded educational experience and prepare students for a globalized world.

Promoting Multilingualism in Practice:

NEP 2020 emphasizes the use of the mother tongue or regional language as the medium of instruction, especially in the early years of education. Implementing a multilingual education policy requires careful planning, resource allocation, and teacher training. Develop and implement curriculum that include instruction in regional languages and mother tongues, ensuring that students receive education in their native languages during the foundational years. Train teachers to effectively teach in multiple languages and to use the mother tongue as a bridge to learning other languages. The policy highlights the role of technology in education and the potential of digital tools for language learning. Utilize digital platforms and apps that support multilingual learning and offer resources in various languages. Promote and offer online courses in different languages to enhance access and learning opportunities for students across regions. The policy suggests the development and availability of textbooks and educational resources in multiple languages. The policy also ensures that the textbooks and learning materials are available in a variety of languages to accommodate the linguistic diversity of students. The NEP 2020 emphasizes the importance of supporting teachers in developing proficiency in multiple languages and integrating multilingual pedagogies into classroom practices. It also calls for the development of high-quality teaching materials and resources in diverse languages to support effective instruction and learning outcomes.

Multilingualism Beyond the Classroom:

Promoting multilingualism extends beyond the classroom walls and encompasses various aspects of societal engagement and communication. In a globalized world, proficiency in multiple languages enhances individuals' ability to communicate effectively, collaborate across cultural boundaries, and participate in the global economy. Multilingualism also plays a crucial role in preserving linguistic diversity, promoting social cohesion, and fostering inclusive development.

Conclusion:

The promotion of multilingualism is a cornerstone of the National Education Policy 2020, reflecting India's commitment to harnessing linguistic diversity for inclusive and holistic education. By embracing multilingualism in education and society, India can enhance knowledge acquisition, promote cross-cultural understanding, and foster global collaboration in a rapidly changing world.

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Integrating STEM & STEAM in Teacher Education

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Abstract

The integration of STEM (Science, Technology, Engineering, and Mathematics) and STEAM (which includes the Arts) into teacher education is gaining momentum in India in response to the evolving demands of 21st-century education. As India implements its National Education Policy (NEP) 2020, there is an increasing emphasis on interdisciplinary learning, creativity, innovation, and problem-solving skills. This chapter explores the conceptual foundations of STEM and STEAM education, the current status in Indian teacher education, challenges in integration, and effective strategies for curriculum redesign. Drawing on global best practices and Indian innovations, the chapter recommends a roadmap to effectively embed STEM and STEAM pedagogies into teacher education programs, preparing teachers to be facilitators of inquiry-based and experiential learning in Indian classrooms.

Keywords: *STEM education, STEAM education, teacher education, interdisciplinary pedagogy, NEP 2020*

Introduction

India's educational landscape is undergoing significant transformation, driven by global advancements in science and technology and domestic educational reform through NEP 2020. A central focus of these reforms is fostering 21st-century skills among learners, such as critical thinking, collaboration, creativity, and innovation. Integrating STEM and STEAM education into teacher education programs is a strategic step toward achieving these objectives. STEM/STEAM is not just an instructional model but a pedagogical shift that encourages inquiry, exploration, and project-based learning. For teacher educators, this implies a fundamental rethinking of content delivery, instructional strategies, and assessment practices.

Conceptual Understanding of STEM & STEAM

STEM education emphasizes the interconnectedness of Science, Technology, Engineering, and Mathematics, aiming to develop analytical and problem-solving skills. STEAM extends this framework by integrating the Arts—thus promoting creativity and holistic thinking. While STEM prepares learners for technical challenges, STEAM encourages a broader approach to learning by combining logic with aesthetic expression. Both approaches prioritize experiential and constructivist learning, wherein learners build knowledge through real-world applications and interdisciplinary projects.

Relevance to Indian Teacher Education

In India, teacher education traditionally emphasizes theoretical knowledge, with limited focus on interdisciplinary and experiential approaches. However, NEP 2020 emphasizes multidisciplinary education, experiential learning, and the integration of technology. Integrating STEM/STEAM into teacher training aligns with these reforms. It helps pre-service and in-service teachers design learning experiences that are inquiry-based, collaborative, and aligned with real-life contexts.

The NCF for Foundational Stage (2022) and the NCF for School Education (2023) stress the need for active, integrated pedagogies and recommend teacher preparation programs be reoriented to support these principles. Therefore, STEM/STEAM integration into teacher education has become essential to ensure that future teachers can foster creativity and innovation among students.

Current Status and Initiatives in India

Several Indian institutions and education boards have initiated efforts to introduce STEM/STEAM in schools, yet the incorporation into teacher education is still in a nascent stage. Initiatives include:

- **CBSE's STEM workshops** for school educators.
- **Atal Tinkering Labs (ATL)** under NITI Aayog that promote innovation skills.
- **Rashtriya Avishkar Abhiyan (RAA)** by MHRD to promote interest in STEM.
- Some **DIETs and SCERTs** have begun offering modules on integrated learning.
- **NCERT's ePathshala and NISHTHA training programs** incorporate elements of digital and science-based learning.

However, most teacher education colleges have yet to adopt a structured STEM/STEAM framework within their B.Ed. or M.Ed. curricula.

Challenges in Integration

Despite policy support, several barriers hinder the effective integration of STEM/STEAM in teacher education:

- **Rigid Curriculum Structure:** Most teacher training programs still follow a discipline-centric approach.
- **Lack of Faculty Training:** Teacher educators themselves often lack exposure to integrated or inquiry-based pedagogies.
- **Inadequate Infrastructure:** Laboratories, ICT tools, and maker-spaces are limited, especially in rural institutions.
- **Assessment Practices:** Emphasis on rote learning continues to dominate, with limited room for project-based assessment.
- **Cultural Mindset:** Both faculty and student-teachers may resist non-traditional pedagogies due to fear of complexity or failure.

Pedagogical Strategies for Integration

To successfully embed STEM/STEAM in teacher education, the following pedagogical strategies are recommended:

- **Project-Based Learning (PBL):** Teacher trainees can work on interdisciplinary projects (e.g., building low-cost water filters combining science and social studies).
- **Inquiry-Based Teaching:** Encouraging questioning, exploration, and problem-solving through classroom experiments.
- **Design Thinking:** Training teachers to guide students through empathetic, iterative problem-solving processes.
- **Collaborative Learning:** Peer teaching and group tasks that integrate multiple disciplines.
- **Technology Integration:** Using simulations, coding platforms, and AR/VR tools to make concepts interactive.
- **Art Integration:** Linking STEM with music, drawing, storytelling, or drama to foster holistic learning. For example, using rangoli patterns to teach geometric symmetry.

Recommendations and Roadmap

1. **Curriculum Redesign:** Revise B.Ed. and M.Ed. syllabi to include interdisciplinary STEM/STEAM pedagogy modules.
2. **Faculty Capacity Building:** Conduct regular training and exposure visits for teacher educators.
3. **Collaboration with Industry and Research Institutes:** Partner with STEM-based organizations and universities for content and resource support.
4. **Assessment Reforms:** Introduce portfolio-based and reflective assessments for teacher trainees.
5. **Policy Support:** NCERT, NCTE, and SCERTs must develop STEM/STEAM-specific frameworks and teacher handbooks.

Conclusion

STEM and STEAM integration in teacher education is not a luxury but a necessity for India's educational transformation. Equipping teachers with the skills to think critically, teach creatively, and engage students with real-world problems will ensure that the next generation of learners is not just academically proficient but also innovation-ready. This transition demands systemic change—curricular, institutional, and attitudinal—across teacher education programs in India.

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A.G. Teachers College was established by the Ahmedabad Education Society in June, 1952, with the help of donation by Acharatlal Charities. The above donation was purely dedicated for running education of various kinds of inservice training programmes and to strengthen class-room teaching of 21st century. B.Ed. Programme comprises a platform to enhance and enrich innate capabilities lying in the trainees, by organizing various co-curricular activities. College has an upgraded status of CTE (College of Teacher Education) to provide in-service teachers training for three districts of Gujarat. College is proactive in its leadership role by organizing various pedagogical activities through “Centre for Pedagogical Innovation” and NEP taskforce promotes penetration of NEP among stakeholders. The Research Cell is committed to quality research work in the field of teacher education.



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