



EDUCATIONAL EXTRACTS

Vol. 14

Issue 2

July 2026



**A Peer Reviewed Educational Journal of
St. Thomas College of Teacher Education, Pala
Kerala – 686 575**

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EDUCATIONAL EXTRACTS

ISSN 2320-7612

RNI Reg. No. KERENG 2013/48939

Vol. 14

Issue. 2

English Half Yearly

July 2026

Annual Subscription: Rs. 400/-

Printed and Published by Jose P. Mattam, Principal (Rtd.), St. Thomas College of Teacher Education, Pala, Kottayam, Kerala 686 575 and owned by Principal, St. Thomas College of Teacher Education, Pala, Kottayam, Kerala 686 575 and Printed at St. Thomas Offset Printers, Pala Post, Kottayam District, Survey No. 693/1 and 743/3 of Lalam Village Meenachil Taluk of Kottayam District, Kerala - 686 575.

ISSN 2320-7612

EDUCATIONAL EXTRACTS

Vol. 14

Issue 2

July 2026



A Bi-annual Peer Reviewed Educational Journal

St. Thomas College of Teacher Education, Pala, Kerala – 686 575

(Research Centre in Education)

Re-accredited (4th cycle) with A⁺ Grade by NAAC

Website: <https://sites.google.com/view/educational-extracts>, <https://stcte.ac.in/>

Email: educationalextracts@gmail.com

**Statement showing ownership and other particulars about
EDUCATIONAL EXTRACTS**

Place of Publication : St. Thomas College of Teacher Education, Pala,
Kottayam

Periodicity of Publication : Half Yearly

Managing Editor : Prof. Jose P. Mattam

Chief Editor : Dr. Pratheesh Abraham

Printer & Publisher : Prof. Jose P. Mattam, Principal (Rtd.),
St. Thomas College of Teacher Education, Pala,
Kottayam

Nationality : Indian

Address & Ownership : Prof. Jose P. Mattam, Principal (Rtd.),
St. Thomas College of Teacher Education, Pala,
Kottayam

Printed at : St. Thomas Offset Printers, Pala, Kottayam, Kerala

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RELATIONSHIP BETWEEN MENTAL ABILITY AND EMOTIONAL MATURITY AMONG B.Ed. STUDENTS FOLLOWING AN INSTRUCTIONAL PACKAGE IN YOGA

Faimen Paul* & Dr. K. R. Harinarayanan**

Abstract

Teacher education programmes are increasingly recognised as sites for developing not only pedagogical competence but also the cognitive and affective qualities that sustain effective classroom practice. The present study examined the extent of the relationship between Mental Ability and Emotional Maturity scores recorded among B.Ed. students after the administration of an Instructional Package in Yoga. A descriptive correlational design, nested within a single-group pre-test post-test framework, was adopted. The sample comprised 64 second-year B.Ed. students of a teacher education college in Kerala who received a twelve-week, expert-supervised Yoga Instructional Package comprising asanas, pranayama, and meditation. Mental Ability ($M = 37.67$, $SD = 6.10$) was assessed with a purpose-designed objective test, and Emotional Maturity ($M = 145.92$, $SD = 13.16$) was assessed with the standardised Emotional Maturity Scale (Singh & Bhargava, 1990); both instruments were administered after the intervention. Data were analysed using descriptive statistics and Pearson product moment correlation. Results revealed a statistically significant, moderate positive correlation between the post-intervention Mental Ability and Emotional Maturity scores ($r = .50$, 95% CI [.29, .66], $N = 64$, $p < .001$). Because the design is a single-group, post-test-only correlational one, the association is best read as evidence that the two attributes are positively related once the yoga package has been completed, rather than as proof that the package produced correlated gains across the two domains. The outcomes are nevertheless steady with the popular holdings that practice of yoga may employ a complimentary and integrative effect across affective and cognitive domains and provide initial scaffolding for entrenching organized and well-planned yoga instruction within the curricula of teacher education

Keywords: Mental Ability, Emotional Maturity, Yoga Instructional Package, B.Ed. Students, Teacher Education

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Introduction

The purpose of teacher education is to prepare and take the individuals beyond their knowledge in subject matter to achieve cognitive agility and emotional stability so that they became capable of managing unexpected demands in a volatile classroom. This dual charge of teacher education has been explicitly framed by The National Council for Teacher Education (2014) that teacher preparation must take into account the subject knowledge along with the three-dimensional development including cognitive, affective, and dispositional aspects. Mental ability and Emotional ability are the two attributes appear regularly in the narrative on teacher effectiveness: the former indicates the potentials to perceive, learn, reason, and adapt to new places, and the latter stands for the potentials to confront reality, stay steadfast in emotional tension, and manage feelings properly in stress. These two attributes have been customarily explored and established individually, considering them as distinct cubicles in the personality of the student teachers.

However, a conceivable connection between these two domains have been established by Yoga, which is an organized discipline combining the mental, physical, and spiritual dimensions of its practitioners. Experts in yoga like Iyengar (1966), Taimni (1961) Sri Aurobindo (1970) etc have reiterated that the sequences of asana-pranayama-meditation was not intended to train the body alone; rather, it was meant to fix the attention and temperament together. On a similar note, Feuerstein (2003) describes the aim of yoga as an amalgamation of prowess rather than the isolated cultivation of any one of them. The findings of the prior research emphasise that the consistent

practice of pranayama, meditation and asanas has been allied to improved working memory, attention, and processing efficacy as well as with greater self-awareness, self-regulation, and social adjustment. A well-structured yoga package practised on a shared attentional and physiological pathway, cognitive and emotional standing would not vary differently; students' score on one dimension might reasonably be matching to the score on the other as well.

While earlier chapters of the broader investigation from which this study is drawn examined the separate effects of a Yoga Instructional Package on Mental Ability and on Emotional Maturity among B.Ed. students, whether these two outcomes are related once the intervention has concluded has not been addressed. Establishing the extent of this relationship carries both theoretical and practical value. Theoretically, it tests the assumption that yoga is associated with an integrated rather than a fragmented developmental profile. Practically, it informs teacher educators whether a single intervention is likely to be reflected in related standing across both domains, which would justify its inclusion as a unified component of the teacher education curriculum.

The present study was therefore undertaken to determine the extent of relationship between Mental Ability and Emotional Maturity among B.Ed. students after the administration of a Package in Yoga.

Review of Literature

Mental ability has long been conceptualised as a composite of spatial, perceptual, verbal, and reasoning competencies that together predict an

individual's capacity to learn and adapt (Hunter, 1986). In teacher education, mental ability underlies the trainee's capacity to internalise pedagogical content knowledge, plan instruction, and respond flexibly to classroom contingencies.

Emotional maturity, described by Crow and Crow (1962) as the capacity to overcome tension, view oneself objectively, and strive toward an improved integration of thought, feeling, and behaviour, has similarly been treated as indispensable to effective teaching. According to Santrock (2019) emotional maturity occurs within late adolescence and early adulthood, the developmental phase in which most B.Ed. entrants belongs, makes these variables meaningful in a teacher-training cohort. Singh and Bhargava (1990) identified the principal dimensions of emotional stability, social adjustment, personality integration, emotional progression, and independence which determine a teacher's capacity for classroom management and academic interactions.

The potential of yoga for determining cognitive and affective outcomes has been established by separate body of researches. In the reports of Telles et al. (2012) and Field (2011) regular yogic practice is correlated with slow physiological arousal, superior attentional control, and enhanced emotional regulation, promoting a collective triggering mechanism rather than two separate pathways of progress. The influence asana-pranayama-meditation sequence on the autonomic nervous system, with cognitive alertness and emotional steadiness has been emphasized by Nagendra and Nagarathna (1997).

Despite this theoretical convergence, few studies have directly tested the statistical

association between mental ability and emotional maturity scores following a yoga intervention, particularly among B.Ed. students in the Indian teacher education context. The present study addresses this gap.

Objective of the Study

To find out the extent of relationship between Mental Ability and Emotional Maturity among B.Ed. students after the administration of a Package in Yoga.

Hypothesis

H₀: There is no significant relationship between Mental Ability and Emotional Maturity among B.Ed. students after the administration of the Instructional Package in Yoga.

Method

Research Design

A descriptive correlational design, defined by Best and Kahn (2012) as research concerned with describing the degree of association between variables without manipulating them, was adopted to examine the relationship between Mental Ability and Emotional Maturity. The correlational analysis reported in this article was conducted on scores obtained after the administration of the Yoga Instructional Package, within a single-group pre-test post-test framework. Pre-test scores on both variables were also collected as part of the broader investigation and were used elsewhere to assess change on each variable separately; they were not entered into the post-test correlational analysis reported here (see Limitations).

Participants

The sample consisted of 64 second-year B.Ed. students of a teacher education

college in Kerala, selected through purposive sampling, all of whom received the Yoga Instructional Package. The sample included both male and female students, with ages ranging from 20 to 25 years.

The Yoga Instructional Package

The Instructional Package in Yoga was a systematically designed, expert-validated set of yoga-based learning experiences administered over a period of twelve weeks, with five sessions per week of approximately 45 minutes each. Each session followed a structured lesson plan comprising a warm-up, a core practice segment, and a closing relaxation and reflective phase, and was delivered under the supervision of a qualified yoga instructor. The package integrated three components.

Asanas: This includes postural practices like Tadasana, Trikonasana, Vrikshasana, Setu Bandhasana, Paschimottanasana, Bhujangasana, Ardha Matsyendrasana, and Shavasana, beneficial to improve flexibility, postural stability, and neuromuscular coordination at the same time energizing the neurological and endocrine systems.

Pranayama: These are breathing practices like Bhramari, Ujjayi, Nadi Shodhana (alternate nostril breathing), and Kapalabhati with the benefits of regulating enhance oxygenation, autonomic arousal leading to sustained attention and emotional calmness

Meditation and Mindfulness. Guided meditation, *trataka* (focused-gaze concentration), and body-scan mindfulness exercises were used to cultivate present-moment awareness, self-observation, and reflective self-regulation, closing each session and reinforced through brief reflective journaling.

The package was validated for content and instructional appropriateness by experts in yoga education and educational psychology prior to administration, and minor sequencing modifications were incorporated following a pilot session with a non-sample group of B.Ed. students.

Instruments

Mental Ability was assessed using a purpose-designed objective test, developed by the researchers for this investigation and covering spatial vision, perceptual speed, number facility, verbal comprehension, word fluency, memory, and inductive reasoning. The test was piloted with a non-sample group of B.Ed. students prior to administration, and item-level screening together with expert review was used to establish its content adequacy; reliability and validity coefficients computed for the present sample should be reported alongside the final version of this manuscript, since the test does not yet carry published norms comparable to a standardised instrument.

Emotional Maturity was assessed using the standardised Emotional Maturity Scale (Singh & Bhargava, 1990), covering emotional stability, emotional progression, social adjustment, personality integration, and independence. The scale's published psychometric properties are well established: a test-retest reliability coefficient of .75 and a validity coefficient of .64 against an external criterion of general adjustment have been reported for the instrument (Singh & Bhargava, 1990). These figures describe the scale's established properties rather than coefficients recomputed for the present sample.

Procedure

Following institutional permission, the sample was pre-tested on Mental Ability and

Emotional Maturity. The Yoga Instructional Package was then administered over twelve weeks under expert supervision. On completion of the intervention, both tools were re-administered as post-tests. The post-test scores of Mental Ability and Emotional Maturity, obtained after the administration of the Yoga Instructional Package, were used for the correlational analysis reported here.

Results

Descriptive Statistics

Table 1

Descriptive statistics for Mental Ability and Emotional Maturity after the administration of the Yoga Instructional Package (N = 64)

Variable	N	Mean	SD	Minimum	Maximum
Mental Ability	64	37.67	6.10	23	50
Emotional Maturity	64	145.92	13.16	116	174

Higher scores indicate greater Mental Ability and greater Emotional Maturity. The findings suggest moderately high levels of both attributes among B.Ed. students following the yoga intervention.

Test of Normality

Table 2

Skewness and kurtosis values for study variables (N = 64)

Variable	Skewness	Kurtosis
Mental Ability	-0.32	-0.49
Emotional Maturity	0.07	-0.23

Values within ± 1 indicate approximate normal distribution. Both variables fall within acceptable limits, justifying the use of Pearson product moment correlation.

Statistical Analysis

Descriptive statistics (mean, standard deviation, minimum, and maximum) were computed for both variables. Skewness and kurtosis values were examined to confirm the appropriateness of parametric analysis. Pearson product moment correlation was computed to determine the extent of relationship between Mental Ability and Emotional Maturity.

Correlation Analysis

Table 3

Pearson correlation between Mental Ability and Emotional Maturity after the administration of the Yoga Instructional Package (N = 64)

Variable	1	2
1. Mental Ability	-	-
2. Emotional Maturity	0.50**	-

** $p < .001$ (two-tailed); $df = 62$.

A statistically significant, moderate positive correlation was found between Mental Ability and Emotional Maturity after the administration of the Yoga Instructional Package ($r = .50$, 95% CI [.29, .66], $N = 64$, $p < .001$). B.Ed. students who scored higher on Mental Ability also tended to score higher on Emotional Maturity, and the null hypothesis of no relationship (H_0) was rejected.

Summary of Hypothesis Testing

Table 4

Summary of hypothesis testing

Hypothesis	Statistical Test	Result	Decision
Hypothesis 1 (H0)	Pearson r	$r = 0.50, p < .001$	Null hypothesis (H0) rejected

Interpretation of Findings

The moderate positive correlation obtained between post-intervention Mental Ability and Emotional Maturity scores ($r = .50$) indicates that the two variables are meaningfully associated among B.Ed. students who had completed the Yoga Instructional Package. Approximately 25% of the variance in Emotional Maturity scores was shared with Mental Ability scores ($r^2 = .25$). Because the design does not include a comparison group and the analysis is limited to post-test scores, this association on its own cannot establish that the yoga package produced correlated gains in the two domains; it is equally consistent with a pre-existing trait-level relationship between the constructs, or with method variance common to two instruments administered on the same occasion. The interpretation of this data shows that higher Mental Ability was inclined to co-occur with higher Emotional Maturity in this cohort and at this point in the intervention. This depicts a pattern in alignment with the broader literature on yoga working through a joint attentional and physiological pathway (see Discussion), even though the present data is not strong enough to confirm that mechanism.

Discussion

The finding of this study confirms that after the yoga intervention Mental Ability

and Emotional Maturity of the sample group do not act in separate, unrelated channels. This findings is consistent with the view of the earlier yoga research, that asana, pranayama, and meditation practice do not go independently in cognition and emotion. This is supported by the reports of Telles et al. (2012) and Field (2011) that practice of regular yoga is concomitant with diminished physiological arousal, enhanced attentional control, and improved emotional regulation. In the similar vein, Nagendra and Nagarathna (1997) confirmed that the asana- pranayama- meditation series acts cumulatively on the autonomic nervous system, with impacts on both emotional composure and cognitive readiness. Incongruence with that literature, one credible explanation of the present findings is that amended attentional control and lessened physiological arousal, both plausibly braced by steady pranayama and meditation practice, may instantaneously support more effectual cognitive processing and steadier emotional management. This echoes an explanation drawn from former work rather than a mechanism exactly tested here, as there is no attentional, autonomic, or neurophysiological measures were collected in the present study.

From the perspective of teacher training, the connection remains significant and deserves careful consideration. A future teacher who demonstrates strong reasoning,

planning, and adaptability skills is also likely, based on this evidence, to be more emotionally stable and socially balanced. These qualities are both important and work together to influence how well a teacher performs in the classroom. The fact that the link between these traits is moderate rather than strong indicates that while they tend to develop together in a meaningful way, they are still distinct enough to be treated as separate areas for development within teacher education programs.

Educational Implications

Teacher education institutions may consider incorporating structured yoga instruction, combining asana, pranayama, and meditation, as a regular curricular component rather than an occasional co-curricular activity, given its apparent capacity to support cognitive and emotional development simultaneously. Teacher educators and curriculum designers could use the present findings to justify allocating dedicated instructional time to yoga practice within the B.Ed. programme. Counselling and mentoring cells within colleges of teacher education may also draw on yoga-based modules to support students who present with difficulties in either cognitive functioning or emotional adjustment, given the observed association between the two.

Limitations

Several limitations qualify the present findings. The design is a single-group pre-test post-test arrangement without an untreated comparison group, so the observed post-test association between Mental Ability and Emotional Maturity cannot be attributed to the Yoga Instructional Package as opposed to a pre-existing trait-level relationship between the

two constructs, ordinary maturation over the twelve-week period, or method variance shared by two instruments administered on the same occasion. The analysis reported here also correlates post-test scores rather than pre-post gain or change scores; a significant post-test correlation establishes that the two attributes are related once the intervention has concluded, not that improvement in one accompanied improvement in the other. Correlating gain scores directly, or comparing the pre-test and post-test correlations between the two variables, would allow a stronger test of the developmental claim and is recommended for future work with this dataset. The sample was drawn by purposive sampling from a single teacher education college in Kerala ($N = 64$), which limits the generalisability of the findings to B.Ed. students elsewhere. The Mental Ability test used in this study was purpose-designed for the investigation rather than an established, normed instrument, so its properties are not yet as well documented as those of the standardised Emotional Maturity Scale. Finally, no attentional, autonomic, or neurophysiological measures were collected, so the shared-mechanism explanation offered in the Discussion remains an interpretation grounded in prior literature rather than a claim tested directly in this study.

Conclusion

The present study found a statistically significant, moderate positive relationship between Mental Ability and Emotional Maturity scores among B.Ed. students following the administration of a twelve-week Instructional Package in Yoga. Within the limits of a single-group, post-test correlational design, the findings

are consistent with the view that yoga practice is associated with related standing across cognitive and affective domains of development among prospective teachers. Embedding structured yoga instruction within teacher education programmes may therefore offer a promising, though not yet conclusively proven, means of nurturing both the intellectual and emotional competencies required for effective teaching; confirming a developmental role for yoga will require controlled, gain-score designs building on the present correlational evidence.

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BEYOND VIDEO LESSONS: GENERATIVE AI FOR CONCEPTUAL UNDERSTANDING OF RELATIVITY IN PHYSICS: IMPLICATIONS FOR PHYSICS TEACHER EDUCATION

Sangeetha C. Kaimal* & Dr. Lavina Dominic**

Abstract

“The Theory of Relativity” is one of the most conceptually demanding topics in physics, requiring learners to understand abstract ideas such as space-time, time-dilation, and length-contraction that cannot be directly experienced. Instructional approaches, including classroom lectures and video-based learning resources, often provide standardised explanations but offer limited opportunities for personalised interaction and conceptual exploration. The need of this conceptual paper is to present the capability of Generative Artificial Intelligence to improve the learning quality. Using recent literature on Generative AI and physics education, the paper discuss how AI-supported learning can outstand traditional instruction by giving more conceptual understanding while also says the importance of teacher guidance, ethical use, and critical evaluation of AI content. The paper also sees the effects of integrating Generative AI into physics teacher education programmes to prepare future teachers use it effectively. It concludes that Generative AI, when used responsibly under teacher supervision, has considerable potential to enrich physics teaching and support meaningful conceptual learning.

Keywords: *Generative Artificial Intelligence; Physics Education; Theory of Relativity; Conceptual Understanding; Teacher Education; Personalised Learning; Educational Technology.*

Introduction

Artificial Intelligence (AI) emerged as one of the most important technological developments in present education, changing

the ways in which teaching and learning are designed, delivered, and evaluated. “Recent development in Generative Artificial

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Intelligence have expanded possibilities by the creation of personalised explanations, interactive conversations, experienceable learning and adaptive experiences that respond to learners' individual needs" Mayer, 2021; UNESCO, 2023. Unlike conventional digital learning resources, Generative AI supports adaptable learning environment and immediate feedback, thereby encouraging active engagement with subject content.

Physics is considered as a discipline that require learners to develop conceptual understanding abstract thinking and also mathematical reasoning. Among its topics, "Einstein's Theory of Relativity" is particularly challenging because it introduces abstract concepts such as spacetime, time-dilation, length-contraction, and the relativity of simultaneity, which cannot be directly observed in everyday life. Consequently, many students memorise equations without developing meaningful knowledge of the underlying physics concepts.

Traditional instructions like textbooks, classroom lectures, animations, and recorded video lessons, have significant role in physics education. However, these resources generally provide fixed explanations. Personalised learning does not happen here. Generative AI gives an alternative instructional approach by allowing learners to explore concepts using customised explanations, interactive questioning, and dynamic visual representations.

From the viewpoint of teacher education, these developments have important implications. Pre-service and in-service physics teachers require more opportunities to develop the pedagogical

knowledge necessary to integrate Generative AI effectively into classroom practice. Rather than replacing teachers, Generative AI should be viewed as a pedagogical support tool that can facilitate inquiry-based learning, conceptual understanding, and differentiated instruction.

The goal of this paper is to assess the potential of Generative AI to support the conceptual understanding any abstract concepts in physics. taking relativity as an example and to discuss its implications for physics teacher education. Analysing recent literature, the paper highlights both the educational opportunities and the limitations associated with the use of Generative AI in teaching abstract scientific concepts.

Theoretical Framework

The discussion presented in this paper is informed by two complementary educational perspectives: Constructivist Learning Theory and Mayer's Cognitive Theory of Multimedia Learning. Constructivist theory says that learners actively construct knowledge by connecting new information with their prior experiences through exploration, reflection, and interaction, therefore meaningful conceptual understanding develops when learners are engaged in questioning, problem-solving, and enquiry.

Mayer's Cognitive Theory of Multimedia Learning Mayer, 2021 suggest that learners understand complicated things effectively when verbal explanations are added with meaningful visual representations. The visualisations, personalised explanations, and interactive experience generated by Artificial Intelligence seem closely with these principles by supporting learners

in constructing good understanding of abstract scientific phenomena. Together, these theoretical approaches provide the conceptual foundation for examining the educational capacity of Generative AI in teaching abstracts and preparing future physics teachers to integrate AI into classroom practice.

Purpose of the Paper

This conceptual paper examines the educational potential of Generative Artificial Intelligence in facilitating conceptual understanding of abstract concepts in Physics, taking “Einstein’s Theory of Relativity” as an example. Looking to many related literatures, the paper discusses how AI-generated explanations, visualisations, simulations, and interactive dialogue will complement to traditional instructional approaches, mainly video lessons which is at times equated to AI. Particular importance is given to the implications of these developments on physics teacher education, including pre-service teacher preparation, professional development, and responsible classroom integration used AI technologies. As a conceptual paper, the article presents contemporary literature and educational perspectives rather than reporting original empirical research.

Review of Literature

The rapid development of Artificial Intelligence (AI) highly influenced educational practices by enabling more personalised, interactive, and learner-centred methods for teaching and learning. Among these developments, Generative Artificial Intelligence (Generative AI) has emerged as a promising technology capable of generating text, images, simulations, and interactive explanations that support

conceptual learning across disciplines. Recent research says that Generative AI has high ability to transform science education and promote active engagement, adaptive instruction, and conceptual understanding.

According to Mayer 2021 “meaningful learning happens when learners actively integrate verbal and visual information to construct coherent mental models”. Multimedia learning environments combine words, diagrams, animations, and learner interaction which provides deeper conceptual understanding than text-only instruction. These principles provide a strong theoretical foundation for the educational use of Generative AI.

UNESCO 2023, says that “educational institutions should use AI responsibly while ensuring transparency, equity, ethical use, and teacher supervision. Rather than replacing teachers, AI will function as a pedagogical support tool that enhances learning experiences while preserving teachers’ professional judgement”.

Within science education, Cao et al. 2023 describe that “Generative AI improves students’ understanding of STEM concepts by explanations which suits every learner, analogies, and visual representations tailored to learners’ needs”. Such adaptive representations are valuable when teaching abstract scientific phenomena that require learners to visualise processes by everyday experience.

Similarly, de Souza et al. 2024 investigated “the use of AI-generated visualisations to teach relativity and reported that carefully designed visual representations enhanced high school students’ conceptual understanding of space-time and relativistic phenomena”. Their findings point that AI-supported

visualisation can reduce understanding difficulties associated with learning highly abstract physics concepts.

A recent review by Roziqin et al. supporting the integration of Artificial Intelligence in physics education. The review said that AI applications contribute to improved conceptual learning, learner engagement, personalised instruction, and enhanced feedback methods. But the authors also said about challenges related to teacher training, ethical considerations, and similar access to AI assisted teaching in all schools.

From the viewpoint of teacher education, Gousopoulos, 2024 explored “an inquiry-based instructional approach using a customised OpenAI GPT for teaching Special Relativity”. This study proved that AI-assisted inquiry helps learners to ask questions, clear doubts, and make conceptual understanding through regular interaction, supporting constructivist learning.

AI offers considerable educational opportunities but researchers have also identified important limitations. Łodzikowski et al. 2023, cautioned that AI-generated responses may contain factual errors or “hallucinations”, making teacher guidance essential during classroom implementation. Similarly, Tzirides et al., 2023, argued that effective educational integration of Generative AI requires appropriate pedagogical planning, ethical awareness, and critical evaluation of AI created material.

The existing literature suggests that AI has high ability to support conceptual learning in physics through personalised explanations, visualisations, and interactive learning experiences. However, its successful use depends upon teachers who

possess both technological competence and sound pedagogical judgement. This gives the importance of need for AI literacy and pedagogical training into physics teacher education programmes.

Generative AI for Conceptual Understanding of Relativity

“Einstein’s Theory of Relativity” is one of the most abstract topics in physics because it requires learners to think about phenomena that are beyond direct human experience. Concepts such as space-time, time-dilation, length contraction, the relativity of simultaneity, and spacetime curvature demand high levels of spatial reasoning and conceptual visualisation. Consequently, students frequently develop procedural knowledge of mathematical equations without acquiring a meaningful knowledge of the physical principles they represent.

Traditional instruction, including classroom lectures, textbooks, animations, and recorded video lessons, provide valuable explanations of these concepts. However, these resources provide present fixed explanations that cannot easily accommodate learners’ diverse backgrounds, misconceptions, or learning preferences. Students who fail to understand a particular explanation often have limited opportunities to seek immediate clarification.

Generative Artificial Intelligence introduces a more learner-centred approach by enabling personalised interaction and adaptive instruction where learner can move forward in his own pace. Rather than presenting a single explanation, AI can generate multiple explanations, analogies, diagrams, simulations, and examples

according to the learner's prior knowledge and cognitive needs. Such adaptability go hand in hand with constructivist approaches to learning, in which learners actively construct understanding through exploration, questioning, and reflection.

One of the major contributions of Generative AI is that it can produce dynamic visualisations of abstract physical phenomena. For example, AI generate customised illustrations of space-time, or simulate the curvature of spacetime around massive celestial bodies. These visualisations allow learners to connect mathematical expression with physical meaning, and reduces the cognitive needs associated with understanding highly abstract concepts.

Generative AI also facilitates interactive thought experiments, which were central to development of relativity. Learners may ask questions like "What would happen if a spacecraft travelled at 99% of the speed of light?" Unlike recorded instructional videos, AI tools can respond immediately, modify explanations according to questions by learner, and encourage deeper concept understanding. This help in inquiry-based learning and promotes higher-order thinking.

Another important advantage is that Generative AI will identify and address student misconceptions. Learners frequently misunderstand relativity by assuming, for example, that clocks slow because they malfunction or that objects physically compress during length contraction. Through continuous interaction, AI provide corrective explanations, alternative representations, and additional examples that help learners reconstruct scientifically accurate concepts, such explanations should always be critically evaluated under

the guidance of teachers, as AI-generated responses may occasionally contain inaccuracies.

Generative AI also bridge the gap between mathematical formalism and conceptual reasoning. Consider the spacetime interval equation in relativity, instead of just presenting this equation, an AI system can explain the physical significance of each variable, demonstrate how the equation applies to different reference frames, and generate visual representations that illustrate invariant spacetime intervals. Such personalised explanations can help learners understand the relationship between mathematical expressions and physical reality.

More than this, Generative AI generates real contexts that illustrate the practical importance of relativity. Examples involving Global Positioning System (GPS) satellites, gravitational time-dilation, particle accelerators, and astronomical observations help learner to recognise that relativity is not just a theoretical construct but essential component of modern science and technology.

From the view of teacher education, these capabilities provide valuable opportunities for future physics teachers to explore multiple pedagogical approaches for teaching abstract concepts. Teacher educators can model how Generative AI may be used to develop inquiry-based lessons, differentiated instructional materials, formative assessment tasks, and adaptive explanations while emphasising the importance of critical evaluation and ethical classroom use. Consequently, Generative AI should be viewed not as a replacement for teachers but as an instructional partner that enhances conceptual teaching and supports effective physics pedagogy.

Table 1
Comparison of Video-Based Learning and Generative AI-Supported Learning

Dimension	Video-Based Learning	Generative AI-Supported Learning
Nature of explanation	Provides a fixed, pre-recorded explanation designed for a broad audience.	Generates explanations fast and can adapt them to the learner's questions and needs.
Interaction	one-way limited interaction learners generally watch and listen to the presented content.	Supports continuous dialogue through questions, follow-up prompts, and interactive exploration.
Personalisation	Personalisation is not there because the same video is generally presented to all learners.	Can provide explanations which suits all needs, examples, analogies, and representations based on learner needs.
Visualisation	No change is possible pre-designed animations, diagrams, and demonstrations.	Can generate or adapt visual representations of abstract concepts in response to learner requests.
Feedback and clarification	Immediate individual clarification is generally unavailable within the video itself.	Can provide immediate responses, clarification, alternative explanations, and corrective feedback.
Learner role	Learners mainly receive and process the presented information.	Learners can actively question, explore, test ideas, and engage in thought experiments.
Teacher's role	Teacher selects content, make it suitable with learning need, and supplements the video resource.	Teacher guides AI use, verifies scientific accuracy, designs learning activities, and supports critical evaluation.
Main limitation	Limited adaptability and interaction; misconceptions may remain unaddressed during viewing.	Risk of inaccurate or misleading responses, over-reliance, privacy concerns, and unequal access.

Pedagogical Implications for Physics Teacher Education

The increasing use of Generative Artificial Intelligence into education require the preparation of teachers who can use technologies effectively and ethically based on curriculum. Teacher education

institutions have a important role in training pre-service and in-service teachers with the knowledge and competencies needed to integrate AI meaningfully into classroom, incorporation of AI literacy into physics teacher education has become an important component of contemporary teacher training.

Physics is widely said as a subject that contain abstract concepts which require inquiry-based learning, and conceptual reasoning. Generative AI give opportunities to teacher educators to demonstrate innovative instructional approaches that extend beyond traditional lecture methods. By making personalised explanations, interactive simulations, visual representations, and formative assessment, AI helps future teachers in making lesson that give learners with diverse abilities and learning preferences.

Within pre-service teacher education programme like Bachelor of Education (B.Ed.) and Master of Education (M.Ed.), Generative AI when integrated into physics methods courses to strengthen pedagogical content knowledge. Teacher educators may encourage student teachers to use AI as a plan tool for developing lesson plans, design conceptual questions, creating different instructional materials, and generating real-life applications of abstract physics concepts. Such experience enables future teachers to critically evaluate AI-generated materials while using their own instructional decision-making skills.

Generative AI help in reflective teaching practices. Teacher trainees may compare AI-generated lesson plans with their own instructional methods, evaluate the pedagogical strengths and weaknesses of AI-generated explanation, and change them for the needs of particular learners. Such activities will help in critical thinking. increase the understanding that AI function as an educational support tool but not a replacement for professional expertise.

For teacher trainees, professional development programmes can include training on the effective use of Generative

AI for classroom instruction, formative assessment, feedback, and differentiated learning. Workshop may focus usage, design, verification of AI-generated materials, ethical considerations, and strategies for it into inquiry-based physics instruction. Continuous professional training is important for teachers to keep updated about new AI tools and their educational applications.

Above all its educational capabilities, successful classroom integration of Generative AI depends upon teachers' ability to use it wisely. Teachers must evaluate the accuracy of AI-explanations, and make sure if it fits with curriculum objectives, protect learners' privacy, and encourage students to think critically, not accepting all AI-generated responses. Human guidance is unavoidable in scientific reasoning, ethical awareness, and responsible technology use.

Teacher education programme should aim not only to train future teachers with AI tools but also to create AI pedagogical competence. This includes developing knowledge of instructional design, digital ethics, assessment methods, and responsible usage that help teachers to integrate AI and use learner-centred instruction. Properly training teachers in this manner will increase their capacity to use Generative AI as an effective educational tool in physics classrooms.

Limitations and Ethical Considerations

While Generative Artificial Intelligence give considerable opportunities for improving conceptual understanding in physics, its educational use has several limitations and ethical considerations that require careful supervision. Effective

integration of AI into teaching should therefore be guided by professional judgement, and responsible educational practices.

One of the issues with Generative AI is the possibility of generating inaccurate information. AI often produce clear and convincing explanations but they may occasionally present scientifically incorrect statements, fabricate references, or oversimplify. Physics education needs conceptual clarity so teachers must verify the accuracy of AI explanations before using them into classroom instruction.

Another important problem is algorithmic prejudice. AI are trained on large datasets that may contain cultural, linguistic, or disciplinary differences. Therefore, AI-generated steps may unintentionally favour particular viewpoints or omit important viewpoints. Teacher educators and practising teachers should encourage learners to critically evaluate AI-generated information using scientific sources, textbooks, and peer-reviewed literature.

The difference in digital knowledge and accessibility also presents a major challenge. Access to high-quality AI tools depends upon reliable internet connectivity, appropriate digital devices, and institutional resources. Schools located in rural or economically disadvantaged regions may have limited access to these technologies; this will widen existing educational inequalities. Teacher education programmes should therefore prepare future teachers to employ AI flexibly and make sure that meaningful learning can continue through alternative instructional approaches when necessary.

Data privacy and responsible use of student information constitute another ethical concern. Many AI platforms collect user interactions to improve system performance, raising questions regarding confidentiality and data security. Educational institutions should establish clear policies governing the responsible use of AI applications and ensure compliance with relevant data protection regulations. Teachers should also guide students in using AI responsibly and avoid disclosing personal information.

Another limitation is the over dependence on AI-generated explanations. Excessive dependence may reduce opportunities for independent reasoning, scientific inquiry, and problem-solving. Physics education aim not only to transmit knowledge but also to develop analytical thinking, and effective reasoning ability. Generative AI should add to rather than replace activities such as laboratory investigations, mathematical problem-solving, classroom discussion, and teacher-led conceptual explanations.

This says us about the importance of the teacher's professional role. Teachers remain responsible for selecting appropriate instructional methods, evaluating AI-generated lessons, promoting ethical technology use, and improving critical scientific thinking among learners. Generative AI should therefore be viewed as an instructional support tool that enhances, rather than substitutes for, effective teaching.

Conclusion

Generative Artificial Intelligence has given so many new possibilities for improving the teaching and learning of

abstract scientific concepts by providing personalised explanations, visualisations, interactive experiments, and adaptive learning environment where the learner can study in his own pace. In physics education, these capabilities can support learners in developing understanding of abstract concepts.

Not like the conventional video-based instructional resources, Generative AI helps with continuous learner interaction and enables explanations to be adapted according to individual learning needs. This has the capability to promote inquiry-based learning, address misconceptions, and encourage active engagement with convoluted scientific ideas. The educational value of Generative AI depends upon its wise integration into teaching practices under the guidance of knowledgeable educators. Generative AI creates new opportunities for preparing future physics teachers to design technology-enhanced learning experiences. Teacher education should include AI literacy, prompt design, critical evaluation of AI content ethical awareness, and pedagogical strategies that enable teachers to integrate AI responsibly into classroom practice. Professional development programmes for practising teachers should similarly support the effective and ethical use of AI as an instructional resource.

Despite its capabilities, Generative AI is not without limitations. There are problems related to mistakes in giving facts, algorithmic prejudice, unequal access to technology, data privacy, and over-dependence which needs careful observation and continuous teacher supervision. Human expertise, pedagogical judgement, and scientific reasoning remain indispensable in ensuring that AI contributes to educational quality.

Generative AI must be considered as a pedagogical assistant not a replacement for teachers. When used thoughtfully and ethically, it has the potential to enrich conceptual learning in physics while equipping future teachers with innovative instructional approaches suited to the new advancements in twenty-first-century education.

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AI AND LEARNER CREATIVITY: ATTITUDES OF M.Ed. STUDENTS

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Abstract

Artificial Intelligence (AI) is increasingly being incorporated into educational environments, creating opportunities for personalised learning, idea generation and new forms of human–technology interaction. At the same time, concerns have been raised about over-reliance, reduced independent thinking and ethical issues. The present descriptive survey examined the attitudes of 50 M.Ed. students towards AI in education, with particular reference to its perceived influence on learner creativity. Data were collected using a self-constructed online attitude questionnaire organised around four areas: general attitudes towards AI in education, AI and learner creativity, AI in the M.Ed. curriculum, and ethical and practical considerations. Data were analysed descriptively using means and standard deviations. The findings indicate generally favourable attitudes towards AI and strong support for including AI-related learning in teacher education. Participants also recognised a dual character of AI: it was perceived as useful for idea generation, while concerns were expressed about dependency, reduced originality and over-reliance. The study therefore suggests that teacher education should promote AI literacy alongside critical, ethical and creativity-oriented pedagogical use. Because the study used a small convenience sample and self-reported responses, the findings should be interpreted as descriptive and exploratory rather than generalisable.

Keywords: *Artificial intelligence; learner creativity; teacher education; M.Ed. students; AI literacy; creative thinking; educational technology*

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Introduction

Artificial Intelligence (AI) has become an important area of educational research and practice. AI-enabled systems can support adaptive learning, feedback, information access and the generation of alternative ideas, while also raising pedagogical and ethical questions (Luckin et al., 2016; Zawacki-Richter et al., 2019; Williamson & Eynon, 2020). For teacher education, these developments are especially significant because future educators will influence how such technologies are interpreted and used in learning environments.

Creativity is commonly understood as the production of ideas or products that are both novel and appropriate (Runco & Jaeger, 2012). Amabile's (1996) work further emphasises the importance of domain-relevant skills, creativity-relevant processes and motivation. From this perspective, AI should not be treated as inherently creative or creativity-reducing. Its educational value depends on how learners and teachers use it within the creative process. AI may broaden ideation and expose learners to alternative possibilities, but uncritical reliance on generated outputs may reduce opportunities for independent exploration, evaluation and revision.

This duality provides the conceptual basis for the present study. AI is viewed as a potential cognitive and creative support whose influence is mediated by pedagogical use, learner agency and critical judgement. The study focuses on M.Ed. students because they are prospective teacher educators, teachers, curriculum practitioners and educational leaders. Their attitudes are relevant to the future integration of AI within teacher education and classroom practice.

Accordingly, the study explores how M.Ed. students perceive the educational possibilities and risks of AI, particularly in relation to learner creativity, curriculum integration and ethical use. The study is descriptive: it reports the attitudes expressed by the participating students and does not claim to measure actual creativity or establish causal effects of AI.

Review of Literature and Conceptual Framework

Research on AI in education has documented applications ranging from adaptive and intelligent systems to broader data-driven and automated forms of educational support (Luckin et al., 2016; Zawacki-Richter et al., 2019). Such work highlights both opportunities and concerns. AI may improve access to information and support personalised learning, but its educational consequences depend on institutional, pedagogical and ethical choices (Williamson & Eynon, 2020).

The construct of creativity requires particular conceptual care. Runco and Jaeger (2012) define creativity in terms of novelty and usefulness, whereas Amabile (1996) situates creative performance within individual skills, creative processes and motivation. These perspectives suggest that creativity cannot be inferred merely from the production of AI-generated content. In educational contexts, the relevant issue is whether AI-supported activity encourages learners to generate, question, evaluate, transform and refine ideas.

Long and Magerko (2020) draw attention to the conceptual complexity of AI and creativity, while Holmes et al. (2021) discuss the educational promises and implications of AI. Together with

research on AI-supported learning and learning strategies (Sailer et al., 2021), this literature suggests that AI can function as a support for learning without replacing human judgement. However, the possibility of dependency and passive acceptance of generated outputs remains an important pedagogical concern.

In teacher education, attitudes and preparedness matter because teachers mediate the educational use of technology. The present study therefore uses a simple conceptual framework in which attitudes towards AI are examined across four connected domains: (a) perceived educational usefulness, (b) perceived influence on learner creativity, (c) support for curricular preparation, and (d) ethical and practical concerns. The framework does not assume that AI has a uniformly positive or negative effect; rather, it recognises the coexistence of opportunities and risks.

Statement of the Problem

The increasing visibility of AI in educational practice has created a need to understand how future educators interpret its possible benefits and risks. In Kerala, M.Ed. students are being prepared for advanced roles in teaching, teacher education, curriculum work and educational leadership. Their attitudes towards AI may therefore influence future pedagogical decisions. Although AI is often discussed in terms of efficiency and personalisation, its perceived relationship with learner creativity remains insufficiently understood within this population. The problem of the present study is therefore stated as: “What are the attitudes of M.Ed. students towards AI in education and its perceived influence on learner creativity?”

Objectives

1. To describe the general attitudes of M.Ed. students towards the integration of AI in the teaching–learning process.
2. To examine M.Ed. students’ perceptions of the potential benefits and risks of AI for learner creativity.
3. To explore M.Ed. students’ attitudes towards the inclusion of AI-related learning and tools in the M.Ed. curriculum.
4. To describe M.Ed. students’ views regarding ethical and practical considerations associated with AI use in education.

Methodology

Research Design

A descriptive survey design was adopted. The study was intended to describe the perceptions and attitudes reported by the participating M.Ed. students; it was not designed to test causal relationships or to measure the actual creative performance of learners.

Participants and Sampling

The study included 50 M.Ed. students from selected teacher education settings. Participants were selected through convenience sampling on the basis of accessibility. This non-probability sampling approach may have introduced selection bias; consequently, the findings should not be generalised to all M.Ed. students in Kerala or elsewhere.

Instrument

Data were collected through a self-constructed online attitude questionnaire administered using Google Forms. The

questionnaire was organised into four domains: (A) general attitude towards AI in education, (B) AI and learner creativity, (C) AI use and preparation in the M.Ed. curriculum, and (D) ethical and practical considerations. Responses were recorded on a five-point Likert-type scale ranging from Strongly Disagree to Strongly Agree. The present manuscript reports the items for which descriptive statistics are available in the dataset supplied for analysis. As item-level validation indices, the number and qualifications of experts, the pilot-sample details and a reliability coefficient are not available in the study records supplied with this manuscript, no unsupported claims regarding content-validity indices or reliability coefficients are made here. These details should be reported in a future replication or in the final submission if documented by the authors.

Data Collection

The survey link was shared with M.Ed. students through institutional communication channels. Participation was voluntary, and respondents were informed of the purpose of the study and the confidentiality of their responses.

Data Analysis

Data were analysed using descriptive statistics, specifically means and standard deviations, to examine the overall attitudes and perceptions of M.Ed. students regarding Artificial Intelligence and learner creativity. In keeping with the descriptive and exploratory nature of the study, the analysis focused on identifying general response patterns and variations in participants' perceptions. The findings are therefore interpreted descriptively, without claims

of statistical significance or formal null-hypothesis testing.

Results and Interpretation

The results are organised according to the four domains of the questionnaire. Mean scores are interpreted descriptively in relation to the five-point response scale; a value above the neutral midpoint indicates greater agreement, while the standard deviation indicates the extent of variation in responses.

General attitude towards AI in education

Item	Mean	Standard deviation
Q1	4.3	0.6
Q2	4.1	0.7
Q3	4.2	0.5

The available items indicate generally favourable attitudes towards AI in education (overall mean = 4.2).

AI and learner creativity

Item	Mean	Standard deviation
AI helps in generating new ideas	4.4	0.6
AI reduces the need for original thinking	3.5	1.1
AI encourages dependency among learners	3.8	0.9

Participants strongly agreed that AI can help generate new ideas. At the same time, they expressed concern about dependency and possible reductions in original thinking. The comparatively larger standard deviation (1.1) for the item on original thinking indicates greater variation in respondents' views.

AI in the M.Ed. curriculum

Item	Mean	Standard deviation
AI should be included in the M.Ed. syllabus	4.5	0.5
I feel confident using AI in teaching	4.0	0.8

The responses indicate strong support for including AI-related learning in the M.Ed. curriculum. Self-reported confidence in using AI was also favourable, although responses showed more variation.

Ethical and practical considerations

Item	Mean	Standard deviation
AI can negatively impact teachers' creative role	3.7	1.0
Ethical training should be included in AI usage in schools	4.3	0.6
I am concerned about over-reliance on AI in education	3.9	0.8

Participants supported ethical preparation and expressed concern about over-reliance. Responses also suggest that some participants perceived possible implications for the teacher's creative role.

Summary of Findings

- The participating M.Ed. students reported generally favourable attitudes towards AI in education.
- AI was perceived as potentially useful for idea generation, while concerns were also expressed about dependency and reduced independent or original thinking.

- Participants strongly supported the inclusion of AI-related learning in the M.Ed. curriculum.
- Ethical preparation and caution against over-reliance emerged as important concerns.

Discussion

The findings support a balanced interpretation of AI in teacher education. The favourable responses regarding idea generation and curricular inclusion are consistent with the broader literature that presents AI as a potential educational support rather than a substitute for teachers (Holmes et al., 2021; Luckin et al., 2016). At the same time, concerns about dependency and originality are compatible with the conceptual distinction between producing an output and engaging in a creative process. From the perspectives of Amabile (1996) and Runco and Jaeger (2012), creativity involves human judgement, novelty and purposeful development; therefore, AI-generated suggestions should be treated as prompts for evaluation and transformation rather than as final products.

The strong support for ethical preparation also aligns with concerns in AI-in-education scholarship regarding the social and institutional consequences of technology (Williamson & Eynon, 2020). The present findings therefore point towards a teacher-education approach in which AI literacy includes not only technical familiarity but also critical evaluation, responsible use, academic integrity and pedagogical judgement.

Conclusion

This descriptive survey indicates that the participating M.Ed. students were

generally receptive to AI in education while maintaining reservations about its possible effects on learner independence and originality. The highest available mean score was recorded for including AI in the M.Ed. syllabus ($M = 4.5$, $SD = 0.5$), followed by the view that AI can help generate new ideas ($M = 4.4$, $SD = 0.6$) and the need for ethical training ($M = 4.3$, $SD = 0.6$). At the same time, concerns about dependency ($M = 3.8$, $SD = 0.9$), over-reliance ($M = 3.9$, $SD = 0.8$) and possible effects on original thinking ($M = 3.5$, $SD = 1.1$) demonstrate that participants did not view AI uncritically.

The findings suggest that AI preparation in teacher education should combine technical familiarity with creativity-oriented pedagogy, critical evaluation and ethical awareness. AI may be most educationally valuable when it supports learners in generating and refining ideas without displacing independent judgement. However, the small convenience sample, self-reported data and absence of documented psychometric information for the instrument limit the strength and generalisability of the conclusions. Larger studies using validated instruments, transparent reliability evidence and, where appropriate, pre-specified inferential analyses are required.

Limitations

The study is limited by its small convenience sample of 50 M.Ed. students, which restricts generalisability and may introduce selection bias. The study relies on self-reported attitudes and therefore does not measure actual AI use or learner creativity. The cross-sectional design captures perceptions at one point in time in

a rapidly changing technological context. In addition, the available study documentation does not provide complete psychometric details for the self-constructed instrument. Finally, the present results are descriptive and should not be interpreted as evidence of causal relationships or statistical significance.

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THE ROLE OF KERALA STATE LITERACY MISSION AUTHORITY (KSLMA) IN EMPOWERING RURAL WOMEN IN KERALA: AN ANALYSIS

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Abstract

The Equivalency Programme of the Kerala State Literacy Mission Authority (KSLMA) provides an alternative educational pathway for women who were unable to continue formal schooling. This thematic paper explores how the programme contributes to the empowerment of rural women, particularly in shaping their attitudes toward higher education and entrepreneurial activity. The analysis draws on a qualitative, thematic review of KSLMA brochures and instructional materials, published literature on adult education and women's empowerment, and compiled field-level observations and learner accounts gathered from 80 Equivalency Programme students across four centres in the Ernakulam district of Kerala during 2015-2020. Five major themes are identified: renewed academic aspiration, strengthened self-confidence, entrepreneurial awareness, community participation, and livelihood improvement. The findings suggest that equivalency education operates as a transformative platform that nurtures academic motivation, economic preparedness, and personal agency among rural women in Kerala, with implications for the training of adult-education facilitators and teacher educators engaged in non-formal and lifelong learning.

Keywords: *Equivalency Education, Women's Empowerment, Rural Women, Higher Education Aspirations, Entrepreneurship, Literacy Mission, Kerala State Literacy Mission Authority*

Introduction

Kerala has long been acknowledged for its progressive literacy initiatives and its commitment to lifelong learning opportunities for all (UNESCO, 2016). The Kerala State Literacy Mission Authority

(KSLMA) extends this legacy through its structured Equivalency Programme, which offers Class IV, VII, X, and XII level learning opportunities to adults (Kerala State Literacy Mission Authority,

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2020). A considerable proportion of the learners are rural women who discontinued schooling due to financial, cultural, or family-related constraints — a pattern of disrupted schooling and later re-entry that is also documented in the wider literature on continuing education among rural women in India (Verma, 2021).

Facilitators delivering the Equivalency Programme perform a role analogous to that of classroom teachers, collaborating with adult learners who bring different motivations, prior experiences, and constraints than school-age students. As such, this discussion carries direct relevance for teacher education. The education of these facilitators raises questions central to teacher education research: how B.Ed. curricula might address inclusive and lifelong learning, and what pedagogical training adult-education facilitators require to work effectively with returning rural learners. By situating the Equivalency Programme within this frame, the paper aims to inform teacher educators' understanding of non-formal education and to identify implications for facilitator training.

This thematic paper examines how equivalency education empowers rural women by fostering aspirations for higher studies and encouraging entrepreneurial orientation. The discussion reflects the

broader mission of KSLMA to promote educational equity, social inclusion, and economic advancement among women who have previously been marginalised.

Objectives of the Study

1. To examine how equivalency education influences rural women's intentions and attitudes toward pursuing higher education
2. To analyse how the programme enhances entrepreneurial motivation among women learners
3. To identify the role of equivalency education in building self-confidence, leadership skills, and socio-economic participation among rural women

As this is a thematic paper based on secondary sources and compiled field observations rather than a structured primary study, these objectives are addressed through documented learner accounts and existing literature rather than through statistically representative primary data collection. The scope and limits of this evidence base are set out in Section 3 and revisited in Sections 5 and 6.

Methodology

This paper uses a qualitative, thematic approach, drawing on three categories of material, summarised in Table 1.

Table 1
Data sources consulted

Data source	Description	Period
KSLMA brochures and instructional documents	Official programme literature and learning materials of the Equivalency Programme Annual reports of KSLMA	2015-2018

Published literature	Peer-reviewed and institutional sources on adult education, entrepreneurship, and women's empowerment 7 sources (see References)	2013–2021
Field-level observations and learner accounts	Compiled, anonymised accounts of Equivalency Programme learners 80 learners across 04 centres in <i>Ernakulam district</i> <i>One anonymised account- a case study</i>	2015-2020

Themes were generated inductively. Materials were read repeatedly, recurring ideas were coded openly, and codes were grouped into broader thematic categories through iterative comparison and discussion between the authors, consistent with standard practice in qualitative thematic analysis. The five themes reported in Section 4 emerged through this process.

Because no structured interview protocol or survey instrument was administered, the paper does not claim to measure learners' 'intentions,' 'attitudes,' or 'leadership skills' in a primary-data sense. These constructs are instead interpreted as they surface in documented learner accounts and secondary literature; this qualification applies throughout Sections 4 and 5.

Thematic Discussion

1. Revival of Educational Aspirations

Equivalency education rejuvenates the desire to learn among rural women who previously discontinued their studies. The programme's learner-friendly environment — characterised by flexible schedules, collaborative teaching methods, and supportive facilitators — reduces academic hesitation, a pattern consistent with broader findings that continuing

education programmes lower the practical and psychological barriers rural women face when re-entering formal learning (Verma, 2021). Women increasingly aspire to complete SSLC, pursue higher secondary studies, or enrol in job-oriented courses.

One learner's account, compiled during field-level observation and referred to here as "R" to preserve anonymity, illustrates this shift: R discontinued schooling after Class II owing to family responsibilities and enrolled in the Class 4,7,10,12 Equivalency streams in her late thirties. Her experience of combining study with domestic and income-generating work reflects the flexible scheduling and supportive facilitation described above. At present she is an active social activist.

This renewed aspiration demonstrates a shift in women's perception of education as an attainable and meaningful goal.

2. Strengthening Self-Confidence and Agency

The programme creates spaces where women participate in academic discussions, group work, community surveys, and cultural activities. Such experiences enhance self-esteem and help women express their opinions more confidently.

Many women begin participating actively in family decision-making and assume leadership roles within neighbourhood groups. Education thus becomes a tool for challenging gender roles and affirming personal agency, consistent with conceptual accounts of education as a vehicle for women's empowerment (Punia & Kamboj, 2013).

3. Entrepreneurial Awareness and Skill Development

Equivalency programmes incorporate components related to life skills, financial literacy, and awareness of government-supported entrepreneurship schemes. Exposure to these elements encourages many women to consider micro-enterprise opportunities such as tailoring, food-based businesses, agriculture-related ventures, and craft production — a pattern broadly consistent with research linking entrepreneurship-oriented education to stronger entrepreneurial intention even outside conventional higher-education settings (Nabi et al., 2018). Improved literacy and numeracy skills empower women to maintain accounts, approach banks, and use government initiatives designed for small-scale entrepreneurs.

4.4 Social Empowerment and Community Participation

Women engaged in equivalency education gain greater awareness of public health initiatives, local governance, and welfare schemes. Their increased confidence motivates them to join community organisations like Kudumbashree, self-help groups, and local literacy committees. The collective learning environment fosters a sense of solidarity, enabling women to support one another and engage more

actively in community development, consistent with evidence that adult literacy interventions strengthen women's socio-economic participation at the community level (Yadav & Thomas, 2019; Anitha, 2018).

4.5 Livelihood Improvement and Economic Mobility

With educational certification, women access a wider range of employment opportunities and vocational courses. Many leverage their new skills to pursue self-employment or enrol in government-supported training programmes. Enhanced income prospects help women become economically independent and contribute more significantly to their household and community welfare, echoing patterns identified in studies of continuing education and economic mobility among rural women (Verma, 2021).

Key Findings and Discussion

Participation in equivalency education positively influences rural women's intent to pursue higher levels of education (Section 4.1).

Exposure to skill-oriented activities within the programme increases entrepreneurial awareness and readiness (Section 4.3; Nabi et al., 2018).

Women report improved confidence, leadership abilities, and active involvement in community and family decision-making (Sections 4.2, 4.4; Punia & Kamboj, 2013).

The programme connects basic literacy with livelihood opportunities, fostering social and economic empowerment (Sections 4.4, 4.5; Yadav & Thomas, 2019; Verma, 2021).

Read together, these findings extend existing literature on adult and continuing education (Verma, 2021; Yadav & Thomas, 2019) by illustrating how a state-run equivalency system combines literacy provision, entrepreneurship exposure, and community mobilisation within a single, integrated programme, rather than through separate literacy and livelihood interventions delivered in isolation. This integration is consistent with conceptual arguments linking education to empowerment (Punia & Kamboj, 2013; Anitha, 2018), but points to a concrete institutional mechanism — the Equivalency Programme itself — through which that link operates in Kerala's rural context.

These findings should, however, be read as illustrative rather than statistically generalisable. The evidence base combines a limited set of secondary sources with compiled field observations rather than a structured primary data set collected through a defined sampling procedure (see Section 3), and the analysis has not been benchmarked against comparable equivalency or continuing-education programmes outside Kerala. A structured study using interviews or surveys across a defined sample of learners would allow these thematic patterns to be evaluated more rigorously.

Conclusion

The Equivalency Programme of KSLMA serves as a dynamic platform for empowering rural women. Beyond providing academic certification, it reshapes educational aspirations, enhances entrepreneurial potential, and promotes meaningful social engagement. The programme contributes to inclusive

development by equipping women with the skills and confidence needed to participate actively in educational, economic, and civic spheres.

These conclusions should be read in light of the paper's evidence base. As noted in Sections 3 and 5, the review draws on a limited set of secondary sources and compiled, non-randomly sampled field observations rather than a structured primary data set; the themes identified are therefore illustrative rather than statistically generalisable, and no comparison group or baseline was used to isolate the programme's effect from other factors influencing participants' lives.

Strengthening the programme through enhanced vocational training, digital literacy instruction, and mentorship support can further elevate its impact on women's empowerment in rural Kerala. For teacher education specifically, the findings point to the value of incorporating adult and non-formal education pedagogy into B.Ed. curricula, so that future teacher educators are better equipped to support facilitators working with returning rural learners. Future research using structured interviews or surveys across a defined sample of Equivalency Programme learners would help substantiate and extend these thematic findings.

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EFFICACY OF HERBARIUM-BASED INSTRUCTION IN ENHANCING SCIENCE PROCESS SKILLS AMONG SECONDARY-LEVEL STUDENTS

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Abstract

The study examined the efficacy of Herbarium-Based Instruction in enhancing Science Process Skills among secondary school students. The study used a quasi-experimental pretest-posttest non-equivalent group design. The sample consisted of 89 Grade VIII students. The experimental group had 48 students, and the control group had 41 students. Intact class sampling was used for group selection. The intervention lasted one month. The selected unit was “Why Classification?”. Data were collected with a 25-item Science Process Skill Test. The test showed a reliability coefficient of .86. The validity coefficient was .88. Descriptive statistics, gain score analysis, Cohen’s d, and ANCOVA were used for analysis. The experimental group showed higher posttest scores than the control group, with greater learning gains. ANCOVA showed a significant group difference after adjustment for pretest scores, $f(1, 86) = 156.66$, $p < .001$, with a partial η^2 value was 646. Gain score analysis produced a Cohen’s d of 1.90. Both values showed a large practical effect. Findings indicate that Herbarium-Based Instruction can strengthen Science Process Skills among Grade VIII students. The approach can support nature-based science learning at the secondary level.

Keywords: *Herbarium-Based Instruction; Science Process Skills; Secondary Science Education; Experiential Learning; Inquiry-Based Learning; Environmental Education; ANCOVA*

Introduction

Science education helps students understand scientific concepts. It also develops scientific thinking. Students need inquiry skills in science learning. They also need critical thinking and problem-solving skills. Science Process Skills form

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an important part of science learning. These skills include observation, classification, inference, prediction, communication, and interpretation. Students use these skills during scientific activities.

Nature-based teaching brings science learning closer to the natural environment. Students can learn from real objects. Plants provide useful materials for this type of learning. Students can observe plant features in their surroundings. They can compare different plants. They can identify similarities and differences. Such activities give students direct learning experiences.

Herbarium-based instruction uses plant specimens for learning. Students collect plant specimens. They identify the specimens. They preserve and mount them. They label the specimens. They classify the plants. They record their observations. These activities give students opportunities to practise Science Process Skills. They also introduce students to plant diversity and biodiversity.

Earlier studies have used herbarium materials for different learning purposes. Dahlia and Janiarli (2021) reported better biology achievement among students who used herbarium as a learning medium. Monfils et al. (2022) examined plant collection, identification, specimen preparation, and collections based learning. Their findings included gains in botanical knowledge and related learning outcomes. Krosnick et al. (2025) examined herbarium activities with secondary school students. Their study reported gains in botanical understanding, student engagement, and appreciation of plant diversity.

The existing studies give useful evidence about herbarium-based learning.

The studies mainly focus on botanical learning and related outcomes. Science Process Skills have received less direct attention. This issue is important at the secondary school level. The present study examines the efficacy of Herbarium-Based Instruction in enhancing Science Process Skills among Grade VIII students.

Theoretical Framework

The study draws on Experiential Learning Theory. It also draws on Constructivist Learning Theory. Inquiry Based Learning provides another basis for the study.

1. Experiential Learning Theory

Kolb (1984) described learning as a process that develops through experience. The process includes concrete experience. It includes reflective observation. It includes abstract conceptualisation. It also includes active experimentation.

Herbarium activities provide concrete experiences. Students collect plant specimens. They observe the specimens. They compare their features. They preserve the specimens. They classify the specimens. These activities give students opportunities to reflect on their observations. Students also use their observations to develop scientific ideas. The activities connect experience with scientific learning.

2. Constructivist Learning Theory

Constructivist Learning Theory views learners as active participants in learning. Piaget (1972) described knowledge development through interaction with the environment. Students do not simply receive information from the teacher. They develop understanding through their own experiences.

Herbarium Based Instruction gives students an active role. Students examine plant specimens. They compare plant features. They organise information. They discuss their observations. These activities support observation, classification, inference, and critical thinking.

3. Inquiry Based Learning

Inquiry Based Learning involves observation, questioning, investigation, evidence collection, and explanation.

Review of Related Literature

1. Herbarium Based Instruction in Science Education

Table 1

Reviews based on Herbarium based Studies

Study	Participants / Context	Herbarium-based intervention / use	Research design / approach	Main outcome examined	Major finding	SPS explicitly measured?	Relevance to present study / gap
Afif, Wisanti, & Isnawati (2014)	Grade X/Senior secondary biology context	Development of a fern herbarium as a real-object learning medium for plant diversity	Development / educational-resource study	Learning resource for plant diversity	Developed a herbarium intended to provide students with concrete plant specimens for learning plant diversity	No	Establishes the use of herbarium as a concrete botanical learning resource, but not SPS as the outcome
Afifah, Sudarmin, & Widiанти (2014)	Grade VII/ MTs-level integrated science context	Herbarium and insectarium used as supplementary learning media for classification of living organisms	Effectiveness study	Learning outcomes / classification learning	Herbarium and insectarium were used to support learning of classification concepts	Not as a primary construct	Important because it connects herbarium with classification, which is closely related to observation and classification skills, but SPS were not systematically assessed
Octavianti, Ningsih, & Titin (2016)	Grade X SMA students	Hands-on-minds-on method supported by herbarium for biodiversity	Quasi-experimental, nonequivalent control group	Biology learning achievement	The herbarium-supported group achieved significantly higher learning outcomes than the conventional group	No	Provides experimental evidence that hands-on herbarium-supported instruction can improve biology achievement, but not SPS (Jurnal Untan)

The National Research Council (2000) highlighted these processes in science learning.

Herbarium activities include several inquiry processes. Students observe plants. They ask questions about plant features. They collect specimens. They examine evidence. They classify the specimens. They record their findings. They present their observations. These activities provide opportunities for Science Process Skills.

Solikhah & Pujiastutik (2018)	Grade X students	Inquiry-based learning using herbarium media in Plantae	Classroom Action Research; two cycles	Learning achievement and classroom learning process	Herbarium-based inquiry was used to improve learning in Plantae and address limitations of lecture-oriented teaching	Not explicitly measured as SPS	Particularly relevant because it combines herbarium + inquiry + active learning, but the outcome was not a standardized SPS measure (Jurnal Universitas Sebelas Maret) Shows the potential of herbarium as a concrete and engaging learning medium at the school level, but does not establish an SPS effect (UPI Repository) Strong evidence that herbarium can improve learning achievement, but the participants were university students and SPS were not the dependent variable (Atlantis Press)
Firdaus (2020)	45 Grade IX students	Herbarium book as a concrete biology learning medium	Descriptive survey	Students' learning interest	Students' interest in using herbarium books as learning media was examined	No	Very important evidence for authentic, inquiry-oriented herbarium learning, but the study focused on undergraduate biodiversity education and data acumen rather than SPS (OUP Academic) Extends evidence for herbarium as a concrete science-learning medium, but the learners and outcome differ from the present study (Academia Open)
Dahlia & Janiari (2021)	Third-semester Biology Education students	Herbarium used as a learning medium for compound-leaf material	Quasi-experimental, pretest-posttest control group	Biology learning achievement	Experimental-group posttest achievement was significantly higher than the control group; the study reported $p = .006$	No	
Monfils et al. (2022)	148 undergraduate students across 10 courses	Plant collecting, pressing, identification, herbarium preparation, digitization and collections-based learning	Multi-institutional educational intervention with pre/post assessment	Taxonomy, systematics, plant identification, data acumen and self-efficacy	Students demonstrated gains in content knowledge, plant identification resources, self-efficacy and understanding of herbarium/collections data	No formal SPS test, although several activities involved observation, evidence use and data interpretation	
Abadillah & Setyawati (2023)	Grade 4 students	Herbarium used as science learning media for leaf-vein morphology	Pre-experimental, one-group pretest-posttest	Science learning outcomes	Herbarium media was investigated for improving students' science learning outcomes	No	

Nurmayasari et al. (2022)	23 Grade VII junior-secondary students	Students prepared herbarium specimens while learning plant classification	Descriptive qualitative study	Collaboration skills	Examined students' collaboration during herbarium preparation	No formal SPS test	Important because it demonstrates that herbarium-making can involve active participation and collaborative learning, but collaboration—not SPS—was examined (Journal Education and Development) Very high relevance. It directly involves high-school students and structured herbarium-based
Krosnick & Moore (2025)	120 high-school students; matched pre/post data available for 51	Ten modules involving botanical history, plant identification, collection, pressing, mounting, digitization and herbarium use	Mixed-methods; pre/post assessment + student responses + teacher interviews	Plant awareness, plant-group knowledge, attitudes and engagement	Students showed significant improvement in identification of major plant groups and understanding of herbarium activities; teachers reported increased engagement	No formal SPS measure, although activities required observation, evidence use and data-related practices	modules, but the primary outcomes were botanical awareness, knowledge and engagement rather than SPS (New Phytologist Foundation) Provides additional evidence for herbarium-book effectiveness, but again focuses on achievement rather than SPS (Umrah Journal)
Dahlia (2024)	Third-semester Biology Education students	Herbarium book used for plant morphology/ leaf-shape learning	Quasi-experimental, one-group pretest–posttest	Biology learning outcomes	Mean achievement increased from 26.04 at pretest to 68.79 at posttest; Wilcoxon $p < .001$	No	

Table 2
Literature Synthesis Matrix

Author	Participants/ Context	Herbarium activity	Main outcome	Key finding	Relevance to present study
Dahlia & Janiarli (2021)	Students	Herbarium as learning medium	Biology achievement	Improved achievement	Supports herbarium-based learning
Monfils et al. (2022)	Students	Collection and specimen activities	Botanical learning	Learning gains reported	Supports hands-on specimen work
Krosnick et al. (2025)	High school students	Herbarium activities	Plant identification, awareness, engagement	Positive learning outcomes	Supports secondary-level herbarium learning
Present study	Grade VIII students	Structured Herbarium Based Instruction	Science Process Skills	Significant improvement	Addresses the identified gap

Research Gap

Earlier studies have reported several benefits of herbarium based learning. These studies have examined botanical knowledge, environmental awareness, student engagement, and related learning outcomes. Fewer studies have examined Science Process Skills as the main outcome.

The evidence is also limited for secondary school students. Few studies have used a Quasi Experimental, Pretest Posttest Non Equivalent Group Design for this purpose. The use of ANCOVA is also limited in the available literature. The present study addresses this research gap.

Research Hypothesis

H₁: There will be a significant difference in Science Process Skills between secondary school students taught through Herbarium Based Instruction and those taught through the Activity Oriented Method.

Objective of the Study

To determine the efficacy of Herbarium Based Instruction in enhancing Science Process Skills among secondary school students.

Methodology

1. Research Method

The study used a Quasi Experimental method. The purpose was to examine the efficacy of Herbarium Based Instruction in enhancing Science Process Skills.

2. Research Design

The study used a Pretest Posttest Non Equivalent Group Design. Two intact Grade VIII classes participated in the study. One

class formed the experimental group. The other class formed the control group. Both groups completed a pretest. Both groups completed a posttest after the intervention.

3. Variables of the Study

Independent variable: Herbarium-Based Instruction

Dependent variable: Science Process Skills

4. Population and Sample

The population consisted of secondary school students from Ernakulam District, Kerala. One secondary school participated in the study. Two Grade VIII classes were selected through intact class sampling. The experimental group had 48 students. The control group had 41 students. The total sample consisted of 89 students.

The students were not randomly assigned to groups. The study used existing classroom groups. The Pretest-Posttest Nonequivalent Group Design suited this setting. Both groups belonged to the same school. This helped reduce differences in school environment and curriculum implementation.

5. Research Instrument

The investigator developed the Science Process Skill Test. The test contained 25 objective items. Each correct answer received one mark. The maximum score was 25.

The test was based on the Grade VIII Science unit "Why Classification?". Experts examined the content of the test. The validity coefficient was .88. The reliability coefficient was .86. The test was used for both the pretest and posttest.

6. Development and Validation of the Instructional Package

The investigator developed a Herbarium Based Instructional Package for the unit “Why Classification?”. The package included plant collection. It included plant identification. It included preservation and mounting. It also included labelling and classification. Students prepared presentations and reports.

Experts from Botany, Science Education, and Teacher Education reviewed the package. The investigator made the required changes before classroom use.

7. Procedure

The study followed four stages. The first stage involved preparation of the instructional package. Second stage involved expert validation. Third stage involved classroom implementation. Fourth stage involved data analysis.

The students completed the pretest before the intervention. Experimental group received Herbarium Based Instruction for one month. Control group received the Activity Oriented Method. Both groups completed the posttest after the intervention. The researcher analysed the data with descriptive statistics, gain score analysis, Cohen’s *d*, and ANCOVA.

8. Statistical Techniques

The study used the following techniques:

- Mean
- Standard deviation
- Gain score analysis
- Cohen’s *d* (Cohen, 1988)
- ANCOVA
- Partial η^2 (Richardson, 2011)

9. Ethical Considerations

The researcher obtained permission from the school authorities and explained the purpose of the study to the participants. Participation was voluntary. The researcher maintained the confidentiality of the data. The data were used only for research purposes.

Results

1. Descriptive Statistics

To examine the performance of the experimental and control groups before and after the intervention, descriptive statistics including the mean and standard deviation were computed. The results are presented in Table 1.

Table 1
Descriptive Statistics of Science Process Skills of the Experimental and Control Groups

Group	N	Pre-test Mean	SD	Post-test Mean	SD
Experimental	48	48.83	2.32	70.48	2.12
Control	41	45.07	1.19	60.17	3.42

The experimental group obtained a pre-test mean score of 48.83 (SD = 2.32), while the control group obtained a pre-test mean score of 45.07 (SD = 1.19). Following the instructional intervention, the post-test mean score of the experimental group increased to 70.48 (SD = 2.12), whereas the control group achieved a post-test mean score of 60.17 (SD = 3.42).

The descriptive statistics indicate that both groups improved after instruction; however, the experimental group exhibited a greater increase in mean Science Process

Skills scores than the control group. In addition, the lower post-test standard deviation of the experimental group

indicates relatively consistent performance among students following Herbarium-Based Instruction.

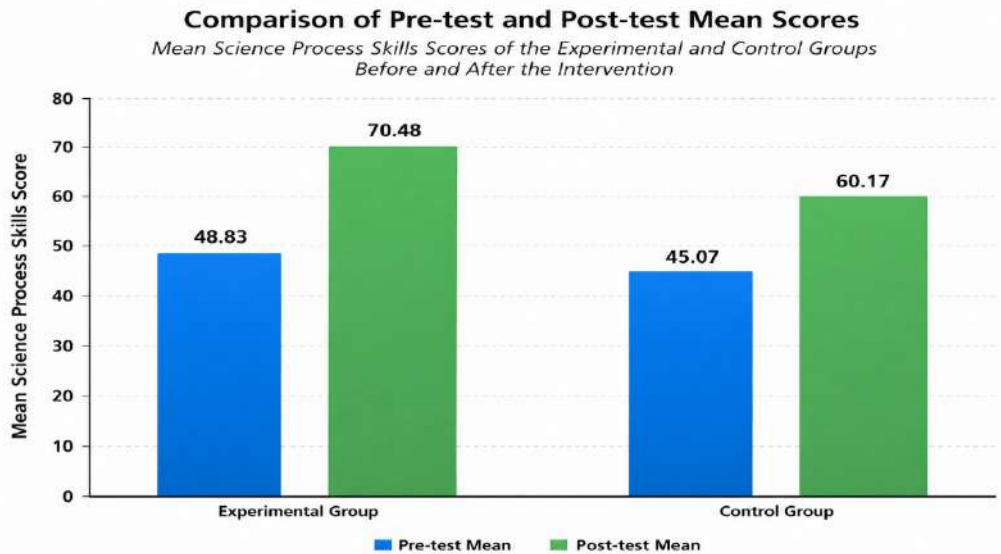


Figure 1: Comparison of Pretest and Posttest Mean Scores

2. Gain Score Analysis of Science Process Skills of the Experimental and Control Groups

Table 2

Gain Score Analysis of Science Process Skills

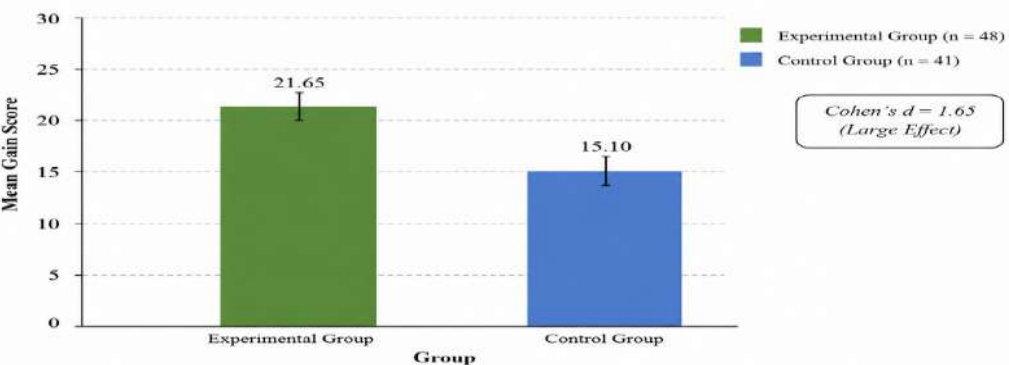
Group	N	Mean Gain Score	SD	Cohen's <i>d</i>
Experimental	48	21.65	3.26	
Control	41	15.10	3.67	1.90

To determine the magnitude of improvement following the intervention, gain scores were computed by subtracting the pre-test scores from the post-test scores. As shown in Table 2, the experimental group

obtained a mean gain score of 21.65 (SD = 3.26), whereas the control group obtained a mean gain score of 15.10 (SD = 3.67). The higher gain score of the experimental group indicates that students who received Herbarium-Based Instruction demonstrated substantially greater improvement in Science Process Skills than those taught through the Activity-Oriented Method.

The magnitude of the intervention was assessed using Cohen's *d*. The obtained effect size ($d = 1.90$) indicates a large practical effect. According to Cohen (1988, p. 40), *d* values of 0.20, 0.50, and 0.80 represent small, medium, and large effect sizes, respectively. Therefore, the observed difference between the experimental and control groups is not only statistically meaningful but also educationally substantial.

Figure 2
Comparison of Mean Gain Scores (Post-test – Pre-test) of Science Process Skills between the Experimental and Control Groups



Note. Error bars represent ± 1 standard deviation.
Gain Score = Post-test Score – Pre-test Score. A higher gain score indicates greater improvement in Science Process Skills.

Figure 2: Comparison of Mean Gain Scores of the Experimental and Control Groups

3. Analysis of Covariance (ANCOVA) of Post-test Science Process Skills Scores

Table 3
Analysis of Covariance (ANCOVA) of Post-test Science Process Skills Scores

Source of Variation	SS	df	MS	F	p	Partial η^2
Pre-test (Covariate)	1.81	1	1.81	0.23	.633	.003
Group	1235.00	1	1235.00	156.66	< .001	.646
Error	677.97	86	7.88			

To determine the effectiveness of Herbarium-Based Instruction after controlling for initial differences between the groups, Analysis of Covariance (ANCOVA) was performed using the pre-test scores as the covariate.

The results presented in Table 3 indicate that the effect of the pre-test covariate was **not** statistically significant ($F = 0.23$, $p = .633$), suggesting that pre-test scores did not significantly influence post-test performance after adjustment. However, a highly significant group effect was observed ($F(1, 86) = 156.66$, $p < .001$), indicating that students who received Herbarium-

Based Instruction achieved significantly higher adjusted post-test Science Process Skills scores than those taught through the Activity-Oriented Method.

The magnitude of the treatment effect was assessed using partial eta squared (η^2). The obtained partial η^2 value of .646 indicates an extremely large effect. According to Richardson (2011, p. 142), partial η^2 values of .01, .06, and .14 represent small, medium, and large effect sizes, respectively. Therefore, Herbarium-Based Instruction exerted a substantial educational impact on the development of Science Process Skills after controlling for pre-test differences.

Table 4

Adjusted Mean Scores of the Experimental and Control Groups on Science Process Skills

Group	N	Pre-test Mean	SD	Post-test Mean	SD	Adjusted Mean	SE
Experimental	48	48.83	2.32	70.48	2.12	70.61	0.49
Control	41	45.07	1.19	60.17	3.42	60.02	0.55

Table 4 presents the adjusted post-test mean scores of the experimental and control groups after controlling for pre-test differences through Analysis of Covariance (ANCOVA). The experimental group obtained an adjusted mean score of 70.61 (SE = 0.49), whereas the control group obtained an adjusted mean score of 60.02 (SE = 0.55). The adjusted means indicate that the experimental group maintained superior performance even after the influence of pre-test differences was statistically controlled. These findings further support the effectiveness of Herbarium-Based Instruction in enhancing Science Process Skills among secondary school students.

4. Tenability of the Research Hypothesis

The present study was undertaken to examine the efficacy of Herbarium-Based Instruction in enhancing the Science Process Skills of secondary school students. The Analysis of Covariance (ANCOVA) revealed a statistically significant difference between the adjusted post-test Science Process Skills scores of the experimental and control groups after controlling for pre-test differences ($F(1, 86) = 156.66, p < .001$). Furthermore, the obtained partial η^2 value ($\eta^2 = .646$) indicated a large treatment effect, demonstrating that Herbarium-Based Instruction exerted a substantial educational influence on students' Science Process Skills. Similarly, the gain score analysis revealed greater improvement among students in the experimental group, and the corresponding Cohen's d (1.90)

indicated a large practical effect (Cohen, 1988, p. 40). According to Richardson (2011, p. 142), the obtained partial η^2 also represents a large effect size. These findings provide strong empirical evidence supporting the effectiveness of Herbarium-Based Instruction.

Hence, the research hypothesis, "There will be a significant difference in Science Process Skills between secondary school students taught through Herbarium-Based Instruction and those taught through the Activity-Oriented Method," is accepted.

Discussion

1. Descriptive Statistics

Both groups improved after instruction. The experimental group showed greater improvement. The mean score increased from 48.83 to 70.48. The control group mean increased from 45.07 to 60.17.

The larger increase in the experimental group may relate to the practical nature of Herbarium Based Instruction. Students collected plant specimens. They observed plant features. They classified the specimens. They recorded their observations. These activities gave students direct experience with scientific materials. This finding is consistent with the experiential learning view of Kolb (1984).

2. Gain Score Analysis

The experimental group obtained a mean gain of 21.65. The control group obtained a mean gain of 15.10. The

difference indicates greater improvement among students who received Herbarium Based Instruction.

The Cohen's d value was 1.90. This value indicates a large practical effect. The result suggests that the difference between the groups was educationally important. The finding also fits the constructivist view of learning. Students worked with plant specimens. They developed understanding through direct experience.

3. ANCOVA Findings

The ANCOVA result showed a significant group difference. The result remained significant after adjustment for pretest scores. The experimental group had a higher adjusted mean than the control group.

The partial η^2 value was .646. This value represents a very large effect. The result gives further support for the effectiveness of Herbarium Based Instruction in developing Science Process Skills.

4. Comparison with Previous Studies

The present findings agree with earlier herbarium based studies. Dahlia and Janiarli (2021) reported improved biology learning outcomes with herbarium as a learning medium. The present study reports a similar benefit in learning. The present study focuses on Science Process Skills.

The present study also adds a different outcome to the existing literature. Earlier studies have examined botanical knowledge and related learning outcomes. The present study examined Science Process Skills among secondary school students. The study also used gain score analysis and ANCOVA.

5. Educational Significance

Herbarium Based Instruction gives students direct contact with plant specimens. Students observe plants. They classify plants. They record information. They communicate their findings. These activities provide useful opportunities for Science Process Skills.

The approach also connects science learning with the natural environment. It can support practical science teaching. It can also increase students' contact with local plant diversity.

Limitations

The study included 89 Grade VIII students from one secondary school in Ernakulam District. The study used a quasi experimental design. The intervention lasted one month. The study covered one science unit.

The findings need careful interpretation beyond this setting. Future studies can include larger samples. Future studies can include more schools. Longer interventions can also be examined. Other science units can be included in future research.

Recommendations

1. Teachers can use Herbarium Based Instruction to develop Science Process Skills.
2. Teacher education programmes can include training in herbarium based teaching.
3. Future studies can examine this approach at different grade levels.
4. Future studies can examine its use in other science subjects.

Conclusion

Herbarium Based Instruction improved the Science Process Skills of the students in the experimental group. The experimental group showed higher posttest performance. It also showed greater learning gains. The ANCOVA result showed a significant group difference. The Cohen's d value was 1.90. The partial η^2 value was .646. Both effect sizes showed a large practical effect.

Herbarium Based Instruction offers a practical approach to science teaching. It gives students opportunities to work with real plant specimens. It also gives students opportunities to practise Science Process Skills. The approach can be useful in secondary science classrooms

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THE ROLE OF EDUCATION IN WOMEN'S EMPOWERMENT IN A MUSLIM-MAJORITY SOCIETY: A STUDY OF ANDROTH ISLAND, UNION TERRITORY OF LAKSHADWEEP

Mohammed Savad P. P. P.* & Dr. Sijo K. Manuel**

Abstract

Education contributes to the empowerment of women, to an improvement in their social status and cultural change, particularly in isolated areas. This study looks at the effects that education has had on society among Muslim women on Androth Island in Lakshadweep, with a specific focus on the Koya¹, Malmi² and Mēlācēri³ social groups. It employs a descriptive approach and based on primary data relating to enrolment at the Government College of Education on Kadmat Island. The study examines three batches of B.Ed. students from 2023–2025, 2024–2026 and 2025–2027, looking at enrolment trends by gender. A total of 103 students were admitted, of whom 90 were girls and 13 were boys. It should be noted that all 35 of the students from Androth were girls, indicating that women have taken part in teacher education. The study also investigates the rise in literacy in Lakshadweep between 1961 and 2011 and examines the implications this has had for the educational empowerment of women. The study concludes that education has acted as a catalyst for expanding women's career opportunities, for reducing gender gaps, for challenging social barriers and for increasing women's active involvement in teacher education, socio-economic activities and public life.

Keywords: Educational changes, women's empowerment, female literacy, gender gap, caste dynamic, Androth Island

Introduction

The right to education is one of the important tools for helping people to

enjoy their other rights (Clapham, 2015). Education is widely seen as ways to help individuals grow improve their lives and

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build a fairer and more productive economy. For women education does more than teach reading and writing. It helps them find jobs get health care make their own decisions and become more active in politics and community matters (Becker, 1964; Sen, 1999). The Sustainable Development Goals, Goal 4 on Quality Education and Goal 5 on Gender Equality recognize that education is a key foundation for achieving gender equality and sustainable development (United Nations, 2015).

Women's empowerment is an steady process. It helps women take control over their lives and make their own choices (Kabeer, 1999). Education plays a role in this process. It helps people become more confident, financially independent, more skilled as leaders more aware of their rights and more involved in decisions that affect their communities. Women who have received education are able to challenge traditions take part in community decisions and help improve the well-being of their families and their local areas (Nussbaum, 2000). The connection between education and women's empowerment is especially important in areas, where schools are hard to reach jobs are difficult to find and social services are scarce.

The Union Territory of Lakshadweep is one of India's unique island groups. It lies in the Arabian Sea. Lakshadweep is made up of 36 islands, most of which have Muslim-majority populations and strong cultural traditions. Even though it is far from the mainland Lakshadweep has made progress in literacy and education thanks to continuous government support in schooling and human development.

Among the islands in Lakshadweep Androth is the populated. It has a history

and better education services compared to others. Androth Island is home to community groups like the Koya, Malmi and Mēlācēri. Each of these groups plays a role in the island's social structure (Dube, 1969).

Traditionally the Koya community had limited access to formal education. This was due to factors: the islands remote location, a lack of schools economic reliance on fishing and coconut farming and deep-rooted cultural practices. In families the focus was on religious education rather than modern schooling. Also male-centered family systems meant that education for women was often seen as less important. Because of these reasons formal education was slow to gain acceptance among Koya women (Kunhaman, 2002; Miller, 2015).

However with growing government efforts things started to change. New schools were built. Scholarships were offered. Educational resources were improved. These actions made modern formal education more accessible and gradually acceptable to all groups. Over time the Koya, Malmi and Mēlācēri communities began to embrace education fully. This shift led to participation in schools especially among women. It also opened doors for social mobility, professional growth and greater involvement in public life.

Objectives of the study

1. To examine how the traditional Muslim way of learning through madrasas changed into the school system on Androth Island and how that change affected education over time.
2. To look at how the Koya people changed their way of learning and focus on what made them join the school system for women.

3. To assess the growth of female literacy in island groups.
4. To analyse the teacher education in Lakshadweep.

Historical development of education

Androth Island, the most crowded island in Lakshadweep has always been a key place for education. Before schools were built education in Androth was given in mosque schools called Madrasas. Children there learned to read the Holy Quran studied Arabic and learned Islamic lessons from local teachers such as Moulavi¹ and Mukri². This way religious education was a part of life but secular learning was almost absent.

Modern education came to Androth in the 1800s when the British were in charge. In 1878 a government school was opened, making Androth one of the islands in Lakshadweep to have a secular school. Teachers from the mainland taught reading, writing, arithmetic and basic Malayalam.. The school faced many problems. Most parents liked the religious schools and did not want their children to go to the new school. Also many children worked in fishing, coconut farming or other chores so they missed classes and many left early.

Another big factor that slowed education on Androth was the island's social rules. The Koya people, who once had power thought that learning only religious lessons was enough to keep their status and culture. They did not see the need for schools and sometimes thought they went against their faith. Because of this modern education grew slowly. The Malmi and Mēlācēri people however soon saw how useful reading and writing could be and how government jobs could help them. After the government built school buildings

in the 1900s these communities began to join formal schools more.

Education on Androth picked up in the 1930s when the Madras Government started scholarships for students to study on the mainland mainly in Calicut. These scholarships opened chances for island children and made families see how good modern education could be. Also adding Quran lessons to the government schools made religious leaders and parents less opposed because children could learn both religion and secular subjects in one place. This mix boosted enrollment. Made the community more comfortable with formal schooling.

After India became independent in 1947 and Lakshadweep became a Union Territory in 1956 education grew fast because the government kept working on it. New schools, teachers, free books, scholarships, hostels and lunch programs all helped more children attend school and stay. Girls' education made gains when the government offered rewards, better buildings and when people started to think differently about girls studying. Many women now work as teachers, nurses, doctors and in government jobs, which lifts their economic status and lets them help the community. Today Androth is known as one of the educated islands in Lakshadweep with many literate people and good schools. This change shows how government plans, community help and social change together boost education women's power and overall growth.

Spread of education among women

The way women learned on Androth Island changed slowly because of religious and cultural shifts. In the past girls could

not get schooling because of old customs, patriarchy and early marriages. Most families thought religious lessons were enough for girls. They did not see modern secular schooling as needed. Because of this girls had chances to study early on.

With these limits girls in Androth went to mosque schools, where they learned to read the Holy Quran and got basic religious lessons. This gave girls a religious education but little chance to learn secular subjects. Moving from religious to schooling was slow because of changes in society and the government's new school programs, which slowly changed how people felt about girls studying.

A big step for women's education on Androth was opening a government elementary school for girls in 1958. Making a school showed that the government saw the social obstacles that stopped girls from learning. It also gave families a reason to send their daughters to school. Having a school made parents feel safer and led to more girls joining school.

Schools on Androth grew during this time too. The Lower Primary School, first built in 1878 became an Upper Primary School in 1960. Then a government high school in 1966 while the lower classes stayed separate. Having a school on the island meant girls no longer had to travel far for secondary school. This made it easier for girls to stay in school and led to more girls going to grades.

After Lakshadweep became a Union Territory the government gave schooling, scholarships, free books, hostels, lunch programs and better school buildings. These changes cut costs made parents more willing to send girls to school and slowly changed how people thought about girls

studying. In Androth educated women now work as teachers, nurses, doctors and in jobs. They also know more about health, their rights and their duties as citizens. This learning gave women money, better status and more help in local government, selfhelp groups and community projects making education the key, to their power.

Status of women

The status of women in Androth Island has long been shaped by the traditions of Lakshadweep. In particular the matrilineal system of inheritance, customs and the islands kinship structure play a big role. Compared to other parts of India the status of women in Androth has always been more favourable. Women in Androth have benefited from an economic position that is strong. Under the system family property goes through the female line. This gives women an amount of economic security and lessens their dependence on male family members. The matrilineal system allows women to keep rights over ancestral property. These rights help women hold a place in the household (Mannadiar, 1977).

Marriage customs in Androth show how women are respected. In the custom a husband must give his wife upkeep. If he does not do this the wife can choose to divorce. In Androth divorce is not a shame. Women can remarry after divorce or after being widowed. These rules give women freedom and safe legal rights in marriage (Mannadiar, 1977).

Even though women in Androth enjoy rights, strict religious and cultural rules, like purdah still keep them from moving freely in public. After independence, the government and new schools opened doors. Women can now study, get jobs and join life more easily (Mannadiar, 1977).

Analysis of the growth of literacy

Table 1

Illustrates the literacy trend in Lakshadweep between 1961 and 2011 shows a change in education.

Sl. No.	Census Year	Overall Literacy (%)	Male Literacy (%)	Female Literacy (%)	Gender Gap
1	1961	23.27	35.80	10.98	24.82
2	1971	43.66	56.48	30.56	25.92
3	1981	55.05	65.24	44.65	20.59
4	1991	81.78	90.18	72.89	17.29
5	2001	86.66	92.53	80.47	12.06
6	2011	91.85	95.60	87.90	7.70

Growth of Literacy in Lakshadweep, 1961–2011

In 1961 the overall literacy rate was 23.27 percent. Male literacy stood at 35.80 percent while female literacy was 10.98 percent. This created a gender gap of 24.82 percentage points. At that time access to education was limited. There were schools, poor roads, weak communication and strong social barriers. Traditional jobs and conservative beliefs kept girls from attending school. Patriarchal views and early marriage were common in rural areas and these made it harder for girls to get an education.

By 1971 things began to improve. The overall literacy rate jumped to 43.66 percent. Male literacy reached 56.48 percent and female literacy rose to 30.56 percent. This progress came from government schools, free primary education, scholarships, free textbooks and hostel facilities. People also started to realize the value of education. Public awareness. More children began to go to school.

In 1981 literacy continued to rise. The overall rate reached 55.05 percent. Male literacy was 65.24 percent and female

literacy was 44.65 percent. The gender gap dropped to 20.59 percentage points. Better school facilities, more teachers and stronger school management helped make this improvement possible. Educational planning became more effective. The government started to focus more on delivering quality education.

The biggest leap happened between 1981 and 1991. The overall literacy rate surged to 81.78 percent. Male literacy reached 90.18 percent and female literacy climbed to 72.89 percent. The gender gap narrowed to 17.29 percentage points. This growth was due to government support. Literacy campaigns reached people. Teachers received training. Secondary education expanded. Adult literacy programmes helped generations.. Better roads and transport made schools more accessible.

By 2001 the literacy rate had reached 86.66 percent. Female literacy increased to 80.47 percent. This showed that policies meant to help girls get an education were working. Scholarships, hostel facilities and

better access to education helped more girls stay in school. The gap between boys and girls was. More women were getting the chance to learn and grow.

The 2011 Census showed the literacy levels yet. The overall literacy rate was 91.85 percent. Male literacy was 95.60 percent and female literacy was 87.90 percent. The gender gap had shrunk to 7.70 percentage points. This meant universal literacy and it showed that educational equality was becoming a reality. Female literacy rose faster than male literacy over the last 50 years. This was a sign of how government efforts and changing social attitudes were helping women gain education.

In all the rise in literacy in Lakshadweep came from a mix of reforms and support. Educational changes, government welfare programmes, better infrastructure, scholarships, free books, midday meals and residential schools all played a role. The experience of Androth Island shows how the shift from education, to modern formal schooling helped women gain more power. It led to social mobility, better human development and more inclusive progress. Education became a way to build a stronger society.

Methodology and Sources of data

The study uses a historical-documentary research approach to look at how education has developed and contributed to women's empowerment in Androth Island, Lakshadweep. The historical and documentary part of the research relies on sources such as Census of India publications the Lakshadweep District Gazetteer, books, government records and published academic studies. These sources help track changes in literacy rates, access

to education and the overall development of education in Lakshadweep. The research does not use surveys, interviews or questionnaires.

To add some real-world data the study uses enrolment records from the Government College of Education located on Kadmat Island, Lakshadweep. The data include three B.Ed. Cohorts: 2023-2025, 2024-2026 and 2025-2027. These records show the sex of students and where they come from. The data were analyzed using frequencies and percentages. The focus was on how many students came from Androth Island and how many were women enrolled in teacher education.

The institutional data are used to give a basis to the discussion on teacher education and women's involvement in professional training. They are not meant to show empowerment nor do they reflect personal attitudes, beliefs or classroom experiences. No interviews or questionnaires were given to B.Ed. Teacher educators. So the results are seen as data about who is enrolling in teacher education programs. They do not prove cause and effect, between education and women's empowerment. They support a factual picture of participation trends.

Analysis of B.Ed. enrolment data

Academic cohort	Boys	Girls	Total
2023–2025	3	25	28
2024–2026	4	37	41
2025–2027	6	28	34
Total	13	90	103

Primary institutional enrolment data supplied for the Government College of Education, Kadmat Island, Lakshadweep.

Across all three cohorts, one pattern stands out clearly: B.Ed. Teacher Education

at the Government College of Education, Kadmat Island, Lakshadweep, has been overwhelmingly female-driven. Women accounted for more than four-fifths of enrolments in every cohort, reaching a high of 90.24% in 2024-2026. Even when this figure eased to 82.35% in 2025-2027, female enrolment continued to far outpace male enrolment which leaves little doubt about who is driving participation in professional teacher preparation at this institution.

That said, numbers like these can only tell us so much. Enrolment data speaks to who is showing up, not to what that participation translates into. It says nothing definitive about whether women's autonomy, decision-making power, income, or social status has shifted as a result, and it would be a stretch to read empowerment directly off these percentages. What the data does support is a more modest but still meaningful claim: women are entering professional teacher training in large numbers, and that entry point matters. It is the kind of access that can, over time, feed into employment, a stronger professional identity, and wider social participation, even if the figures themselves stop short of proving it.

Education as a Catalyst for Women's Empowerment

In every society women have an impact on the lives and well-being of their families and the communities around them (Thankachan et al., 2015). On Androth Island education has played a role in empowering women by improving many areas of their lives. The focus of this discussion is to understand if education has helped women go beyond roles at home and become active members in family life, community life and public life.

Education improves women's standing in society by building self-confidence increasing awareness of their rights and helping them understand their responsibilities. It encourages women to join community groups, self-help groups and local decision-making bodies. This leads to gender equality and more inclusion in social life. Economically education opens doors to jobs, government positions, professional careers, business opportunities and income-generating activities. This helps women become financially independent and strengthens their empowerment.

When it comes to involvement this study looks at whether educated women are more likely to take part in local self-governance, voting, community organisations, Self-Help Groups (SHGs) and other democratic institutions. Education helps women become more aware of politics by increasing knowledge about rights, civic duties, and democratic values and how government works. It also builds confidence, leadership skills and the ability to make decisions. These changes allow women to take part effectively in public affairs and local administration (Basu, 2004; Desai & Thakkar 2001).

On Androth Island education has greatly strengthened the power of women. Educated women have been elected as Chairpersons and Panchayat Members showing how education supports participation and leadership. Education has helped women understand their rights, government programmes and democratic processes. This enables them to take part in decision-making implement welfare schemes and speak for the needs of their communities. It has also helped develop leadership skills by encouraging women

to join institutions, local self-government bodies, self-help groups and community organisations.

Their active involvement has challenged ideas about gender roles and supported inclusive development. In total education has become a force that expands opportunities, for women. It allows them to contribute meaningfully to the economic and political growth of Androth Island.

Discussion of the study

The study shows that women's higher education in Lakshadweep is affected by things. These include the way institutions are set up where people live, how much money families have and the social and cultural environment. There are not higher-education institutions on the islands themselves and there are also very few specialised courses available. Because of this many girls and young women must go to mainland India to continue their studies. This means they have to travel from home which brings extra challenges.

Going to school on the mainland requires transport, a place to stay and money for fees and living costs. For women these issues are even harder because family decisions often focus on safety, distance and whether it is okay for a woman to live away from home. The journey itself can be difficult due to boat services and high travel expenses. These problems make it harder for families to afford education especially for girls.

In addition many families do not know about scholarships, reservation benefits or the types of courses. This lack of information limits their ability to take advantage of what's already offered. So simply opening schools is not enough. There needs to be

support; such as career guidance, financial aid, reliable transportation and clear information about higher-education options.

The cultural environment of Lakshadweep also plays a role. The islands have traditions and close-knit communities. When women leave for mainland universities they face difficulties adjusting to ways of life. They might feel homesick or out of place in places. These experiences affect their confidence and motivation. Families may worry more about sending daughters if they see these challenges.

Because of this schools and policies must understand culture while still encouraging girls to dream big. Educational programs need to respect values but also help women gain independence and professional skills. This balance is key to making progress.

Teachers can play a part in helping girls succeed. They can guide students share information about opportunities and encourage them to keep learning. The B.Ed. Curriculum and teacher-training programs in Lakshadweep should include lessons on gender- teaching, counselling and how to support students who come from remote areas. Teachers trained this way can become mentors helping girls build confidence and reach their goals.

The findings show that women's access to education is shaped by many factors together, how schools are built how far apart places are, money, culture and awareness. To improve participation all these areas need attention at once. Education in Lakshadweep should not be seen as getting more children into classrooms. It should be viewed as a process: giving everyone real access, equal chances, freedom to move, proper training and support for growth. Teacher education

is central, to this change. Prepared teachers can fill gaps in knowledge inspire girls to keep going and create classrooms where every student feels valued and supported.

Limitations of the study

The current research has some limitations that need to be kept in mind when looking at the results. First the research is about Androth Island. This means the results might not apply to all the islands in Lakshadweep. In these islands the schools, the way people move around the money people have and the way people live and act might be different. The research mainly looks at how education affects women's power. It talks about things like not schools for higher education trouble getting around not enough money, changing traditions and not knowing enough about opportunities. These things are specific to Androth Island. But these conditions could change over time because schools might get better roads might improve internet access might. The government might make new rules. So the results should be seen in the place and the culture where the study happened.

Another limitation is about the data on teacher education. The research uses records from the Government College of Education on Kadmat Island. These records cover three groups of B.Ed. Students. They show how many boys and girls from each island are in the program. They don't have personal details from the students, the teachers or the educators. So the research can show who joins the program but can't really find out why they join, how they feel, if they gain power or how good the B.Ed. Courses are. The ideas about teaching preparation are based on the numbers and on documents not on a direct look, at the teacher training programs.

Conclusion

The realization of the right to development for every being and nation is impossible without the recognition of the right to education. The findings of this study clearly show that education has become a catalyst for women's empowerment in Androth Island changing the social economic and political status of women in a society that is mostly Muslim. The shift from a Madrasabased religious system to a modern formal education system has greatly widened opportunities for women letting them take part more actively in family life, community events and public affairs. Continuous government action like building schools offering scholarships providing educational materials, hostels and other welfare programmes has been essential in raising educational access and cutting gender gaps. The study also shows that educational empowerment depends closely on having the institutional support, guidance and professionally trained teachers who can encourage girls' educational dreams and keep them going.

The study reveals that this educational change has improved the chances for the communities of Androth Island. The Koya community first had participation in formal education because of conservative social and religious norms but government efforts, growing awareness and changing economic goals have slowly increased education for women there. The Malmi and Mēlācēri communities started education earlier and have seen greater social and economic mobility. Female literacy rose from 1961 to 2011 showing progress for women's access to education and recent enrolment data show strong female participation in B.Ed. Programs. Across three B.Ed. Cohorts

girls made up 87.38% of enrolment. These figures give evidence of women's involvement in professional teacher training but they should not be taken as direct proof of empowerment outcomes. Together the documentary evidence and enrolment data support the conclusion that expanding education has opened paths for women's professional growth, upward mobility and participation, in public life.

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1. Koyas are the traditional land-owning groups and socially upper class community
2. The Malmis are the traditional sea-based community engaged in navigation and maritime trade
3. The Mēlācēris were the traditional working community involved in coconut cultivation and coir production
4. A Moulavi is a Islamic religious scholar who qualified to teach Islamic theology and lead religious practices.
5. A Mukri is a mosque functionary responsible for giving the call to prayer and helping in religious services.



A REGRESSION ANALYSIS OF SELF-REGULATED LEARNING AND SOCIAL COMPETENCE AS PREDICTORS OF ACADEMIC PERFORMANCE AMONG HIGHER SECONDARY STUDENTS

Ansu Manuel*, Dr. R. Meenakshi** & Dr. Jeyanthi R.***

Abstract

This study investigated how self-regulated learning and social competence predict the academic achievement of higher secondary school students. A quantitative research approach employing a descriptive correlational design was selected. This sample consisted of 1200 students who were drawn from fourteen higher secondary schools in Idukki District, Kerala. The method used for selection was stratified random sampling. Data were gathered using the Self-Regulated Learning Scale (SRLS) developed by Madhu Gupta and Dimple Mehtani, the social competence scale developed by the investigator and students' higher secondary board examination scores. To examine the relationships among the study variables, Pearson's Correlation analysis, Spearman's rank- order correlation analysis, and multiple regression were employed. The findings of these studies indicate significant positive associations between self-regulated learning and academic achievement and between social competence and students' academic success. In addition, multiple regression analysis found that self-regulated learning and social competence were predictive of academic achievement, with a model accounting for 91.0% ($R^2=.910$, $F = 6023.698$, $p < .001$) of the variance between these variables, in which self-regulated learning was the strongest predictor. The study emphasises the importance of promoting self-regulated learning and social competence to enhance academic performance.

Keywords: Self-Regulated Learning, Social Competence, Academic Performance, Higher Secondary School Students, Multiple Regression Analysis

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Introduction

Academic achievement is an important aspect of students' educational success and has been shown to be influenced by cognitive, motivational, and social factors. Over the past several years, educational research has placed greater focus on psychological and social factors that contribute to students achieving better results in learning (Zimmerman, 2002; Blair & Raver, 2015). Amongst the variables which have been found to be associated with academic achievement during higher secondary education (a period of increased demand and greater responsibility for managing one's own learning) are self-regulated learning and social competence.

Self-regulated learning is about students' ability to plan their own study, control it and manage the learning process using appropriate use of cognitive, metacognitive, motivational and behavioural strategies (Zimmerman, 2002). Students who exhibit strong self-regulation skills typically have better organization, motivation, and are able to obtain greater academic achievement. Similarly, social competence consists of effective communication, positive relationships with others, cooperative behaviour, empathy and adaptability when interacting with people in different social environments (Wentzel, 1991). These competencies create an encouraging learning atmosphere that promotes active involvement, teamwork and higher academic achievement.

In addition to this, several studies have identified strong relationships between self-regulated learning, social competence and academic achievement (Blair & Raver, 2015; Hosseini Et Al., 2015). Yet the most of the above studies investigated these variables

separately, with little reference to their joint predictive influence on higher secondary school students' academic achievement. In order to address this gap, the present study utilized multiple regression analysis to determine if self-regulated learning and social competency influence academic achievement. The findings are expected to contribute valuable insights for teachers, school counsellors, and educational planners in developing interventions that promote both self-regulated learning behaviour and social competence. The results of the study may enhance students' academic success by promoting these behaviours simultaneously.

Need and Significance of the Study

Performance at the higher secondary level is an important factor influencing students' future career and educational prospects. While academic achievement has historically been viewed as a product of intelligence, the growing body of research suggests that psychological and social factors (E.G. self-regulated learning and social competence) play a significant role in contributing to students' academic success (Zimmerman, 2002; Blair & Raver, 2015). Students are able to regulate their own learning and plan, monitor and evaluate it successfully due to self-regulated learning but social competence enables students to interact positively with others, collaborate effectively and adapt well to school environment (Wentzel, 1991). Collectively, these abilities contribute to positive student learning outcomes as well as increased student growth and development.

Studies have previously reported significant relationships between self-regulated learning and academic achievement (Zimmerman, 2002) as well as between social competence and academic

achievement (Hosseini et Al., 2015). However, the most of these studies have investigated these variables independently and limited research has investigated their combined predictive influence on the academic performance of higher secondary school students using regression analysis. As such, this study will address the void by exploring self-regulated learning and social competence as predictors of academic achievement. It is sure that the findings of this study will give strong empirical proof for teachers, school counsellors, teacher educators and educational planners working on the development of intervention programs to enhance students' ability to self-regulate their efforts and social competence leading to increased academic performance and overall well-being.

Review of Literature

Studies on Self-Regulated Learning and Academic Performance

Research conducted over recent years has frequently indicated that self-regulated learning (SRL) is a strong predictor of academic achievement in varied educational settings. According to a meta-analysis by Cheng, Zhang, and Xu (2025), there was a significant positive correlation between the use of SRL strategies and academic achievement in online higher education. The authors emphasized the importance of metacognitive, behavioural, and environmental regulation in facilitating academic success. In a similar vein, Lourenco and Paiva (2024) reported that the use of self-regulated learning and effective time management led to better academic achievement for learners, highlighting the importance of planning, goal setting, and self-monitoring in enhancing student achievement.

Numerous empirical studies have shown positive associations between Srl and academic achievement. Dinh and Phuong (2024) found that the positive effects of strategic planning, time management, environmental structuring and seeking help on students' learning satisfaction and academic achievements in MOOCs. Similarly, Fuzi et al. (2024) found that self-regulated learning had a direct and significant impact on students' academic performance in online learning environments whereas self-efficacy alone did not significantly predict achievement. Similar findings were observed by Isufi and Haskuka (2024), who determined that students' self-regulated learning behaviours improved due to supportive parenting styles and positive teacher-student interactions, leading to enhanced academic achievement. Likewise, Mubango and Ngirande (2024) stated that time management is essential to the self-regulated learning process, which can lead to successful academic achievement in blended learning settings. Collectively these studies indicate that self-regulated learning is positively associated with academic performance across diverse educational contexts although strength of association may vary across learners and learning environments.

Studies on Social Competence and Academic Performance

Current research has repeatedly demonstrated that social competence plays a key role in enhancing students' academic achievement and overall development of education. Malik, Ahmed & Riaz (2025) indicated that the positive impact of social competence on academic achievement occurred through interpersonal relationships as mediator factors, highlighting teacher-

student and peer interaction in contributing to student success. The results emphasize the significance of communication, cooperation and interpersonal skills in assisting students to learn.

Other studies have also reinforced the role of social competence in academic achievement. Tabassum (2024) showed that the relationship between psychosocial factors and academic achievement were mediated by social competence, therefore socially competent students are better able to cope with psychosocial problems and reach greater levels of success academically. Similar results were found by Hachem et Al. (2022) who noted that social competence predicted students perceived cognitive competence and academic performance, further emphasizing the importance of supportive social/emotional learning environments. In general, the results suggest that social competence is a key factor in determining academic achievement primarily by way of its effect on students' interpersonal skills emotional well-being and adaptive behaviours.

Research Gap

A review of literature that is pertinent to this study reveals that self-regulated learning and social competence are both predictive factors for academic achievement among students. Studies conducted in various educational environments, including online, blended, and traditional learning settings, consistently documented positive relationships between self-regulated learning behaviours and academic achievement outcomes for students (Cheng et al., 2025; Dinh & Phuong, 2024; Fuzi et Al., 2024). Similarly, studies have demonstrated that social competence contributes significantly

to academic success by promoting effective interpersonal relationships emotional well-being adaptive behaviours (Malik et Al., 2025; Tabassum, 2024; Hachem et Al., 2022).

In spite of these valuable contributions to the literature, there are still several gaps remaining in the existing body of work. Initially, many studies have examined self-regulated learning (SRL) and social competence separately without considering the combined predictive influence of these two factors on academic achievement. Secondly, many studies have focused on university students, online learning environments or specific subject areas. As a result, higher secondary school students are relatively underrepresented compared to other groups studied. Thirdly, only limited number of research has utilized multiple regression analysis to identify contribution of self-regulated learning and social competence in predicting academic achievement. Moreover, empirical studies concerning this topic in India (particularly higher secondary school students) remain scarce.

The present study fills these gaps by analysing how students' self-regulated learning and social competence interact to predict their academic achievement during higher secondary school using multiple regression analysis. These results are anticipated to add to the current body of literature and offer useful suggestions for teachers, school counsellors and educational policy makers developing interventions which support both self-regulated learning and social competence. The result is expected to contribute to the students' academic achievement.

Statement of the Problem

The present study is entitled “**A Regression Analysis of Self-Regulated Learning and Social Competence as Predictors of Academic Performance among Higher Secondary Students**”.

Objectives of the Study

1. To analyse the relationship between Self-Regulated Learning and Academic Performance among Higher Secondary School Students.
2. To analyse the relationship between Social Competence and Academic Performance among Higher Secondary School Students.
3. To determine the predictive influence of Self-Regulated Learning and Social Competence on Academic Performance among Higher Secondary School Students.

Hypotheses of the Study

1. H₀₁: There is no significant relationship between Self-Regulated Learning and Academic Performance among Higher Secondary School Students.
2. H₀₂: There is no significant relationship between Social Competence and Academic Performance among Higher Secondary School Students.
3. H₀₃: Self-Regulated Learning and Social Competence do not significantly predict the Academic Performance of Higher Secondary School Students

Methodology

Research Design

The present study was done through a quantitative research approach and a correlational research design is used. Since the aim of the study was to find

the relationships among Self-Regulated Learning, Social Competence, and Academic Performance of higher secondary school students without manipulating any variables. Pearson's product-moment correlation analysis was employed to examine the relationships between the variables, while multiple regression analysis was used to determine the predictive influence of Self-Regulated Learning and Social Competence on Academic Performance.

Population and Sample

The Higher Secondary School Students in Idukki District, Kerala was selected as a population for this study. A sample of 1200 higher secondary students were selected from 14 higher secondary schools in the district. To select the participants, a stratified random sampling technique was employed to ensure that there would be adequate representation of students from selected higher secondary schools. The selected sample was considered sufficient for assessing the relationships between self-regulated learning, social competency and academic achievement among higher secondary school students.

Tools Used for the Study

The data was collected using tools listed below,

- **Self-Regulated Learning Scale:** Self-regulated learning was measured with the self-Regulated learning scale (SRLS), that was developed and normalized by Madhu Gupta and Dimple Mehtani (2017). The scale was comprised of 48 items that were categorized under six domains: self-awareness, goal setting/planning, self-motivation, self-control/self-

regulation, self-evaluation and self-modification. Responses were measured using 5-point Likert scale, and total score ranged from 48 to 240 with greater scores indicating higher levels of self-regulated learning (Madhu Gupta and Dimple Mehtani 2017). The size was standardized using a sample of 400 secondary school pupils, senior secondary school pupils and college students. The results showed adequate psychometric characteristics, with a split half reliability coefficient of .88, test-retest reliability coefficient of .982 and internal consistency coefficients between .736 to .807 for the 6 dimensions. The scale also demonstrated appropriate face, content, and construct validity. Thus it is a valid and reliable instrument for assessing self-regulated learning among higher secondary school students.

- **Social Competence Scale:** Social competence was measured using the Social Competence Scale developed and standardized by the investigator. The scale comprises 44 items covering five dimensions: Interpersonal Knowledge and Skills, Cultural Competence, Adopting Social Values, Positive Self-Identity, and Decision-Making Skills. The scale demonstrated satisfactory reliability, with Spearman–Brown Split-Half (0.863), Guttman

Split-Half (0.859), and Cronbach’s Alpha (0.759) coefficients (Ansu 2026).

- **Academic Performance:** Academic performance was assessed using the aggregate marks obtained by the students in the Higher Secondary Board Examinations for the academic year 2024–2025. For students enrolled in the Kerala State Higher Secondary stream, marks were obtained from the 2025 Higher Secondary Examination conducted by the Directorate of Higher Secondary Education (DHSE), Kerala, while for students from the Central Board of Secondary Education (CBSE), marks were obtained from the 2025 All India Senior School Certificate Examination (AISSE) conducted by the Central Board of Secondary Education (CBSE). The aggregate marks obtained in all subjects were collected from the official school records and used as the continuous measure of academic performance in the present study.

Analysis and Interpretation

Hypothesis 1

H₀₁: There is no significant relationship between Self-Regulated Learning and Academic Performance among Higher Secondary School Students.

Table 1

Relationship between Self-Regulated Learning and Academic Performance among Higher Secondary School Students

Variables	N	Pearson’s r	Spearman’s ρ	p value
Self-Regulated Learning and Academic Performance	1200	0.946**	0.933**	< .001

Note. $p < .01$.

The results revealed a statistically significant positive relationship between Self-Regulated Learning and Academic Performance among Higher Secondary School Students. Pearson's product-moment correlation ($r = .946, p < .001$) and Spearman's rank correlation ($\rho = .933, p < .001$) indicated that higher levels of Self-

Table 2

Relationship between Social Competence and Academic Performance among Higher Secondary School Students

Variables	N	Pearson's r	Spearman's ρ	p value
Social Competence and Academic Performance	1200	0.745**	0.751**	< .001

Note. $p < .01$.

The results indicated a statistically significant positive relationship between Social Competence and Academic Performance among Higher Secondary School Students. Pearson's product-moment correlation ($r = .745, p < .001$) and Spearman's rank correlation ($\rho = .751, p < .001$) demonstrated that students with higher levels of Social Competence tended

Regulated Learning were associated with better Academic Performance. Therefore, **the null hypothesis (H_{01}) is rejected.**

Hypothesis 2

H_{02} : There is no significant relationship between Social Competence and Academic Performance among Higher Secondary School Students.

to achieve better Academic Performance. Therefore, the null hypothesis (H_{02}) is rejected.

Hypothesis 3

H_{03} : Self-Regulated Learning and Social Competence do not significantly predict the Academic Performance of Higher Secondary School Students

Table 3

Multiple Regression Analysis of Self-Regulated Learning and Social Competence as Predictors of Academic Performance among Higher Secondary School Students

Predictor Variables	B	SE	β	t	p	95% CI for B
Constant	66.077	3.621	—	18.247	< .001	[58.973, 73.182]
Self-Regulated Learning	1.543	0.023	0.828	68.539	< .001	[1.499, 1.587]
Social Competence	0.395	0.028	0.17	14.064	< .001	[0.340, 0.450]

Note. Dependent variable: Academic Performance. β = Standardized regression coefficient.

Table 4

Model Summary of the Influence of Self-Regulated Learning and Social Competence on Academic Performance among Higher Secondary School Students for the Total Sample

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.
1	0.954	0.91	0.909	17.084	6023.698	< .001

Dependent Variable: Academic Performance. Predictors: Self-Regulated Learning and Social Competence.

Prior to conducting the regression analysis, multicollinearity was assessed using tolerance and Variance Inflation Factor (VIF) statistics. The tolerance value for both predictor variables was 0.517, while the corresponding *VIF* value was 1.932, indicating that multicollinearity was not a concern.

The multiple regression model was statistically significant, $F(2, 1197) = 6023.698, p < .001$, explaining 91.0% of the variance in academic performance ($R^2 = .910$; Adjusted $R^2 = .909$). Both Self-Regulated Learning ($\beta = .828, B = 1.543, t = 68.539, p < .001, 95\% CI [1.499, 1.587]$) and Social Competence ($\beta = .170, B = 0.395, t = 14.064, p < .001, 95\% CI [0.340, 0.450]$) were significant positive predictors of academic performance. Among the two predictor variables, Self-Regulated Learning emerged as the stronger predictor of Academic Performance, as evidenced by its higher standardized regression coefficient ($\beta = .828$). Therefore, the null hypothesis (H_{03}) is rejected. Therefore, **the null hypothesis (H_{03}) is rejected.**

Major Findings of the Study

- A highly significant positive relationship was found between Self-Regulated Learning and Academic Performance among higher secondary school students ($r = .946, p < .001$), indicating that students with higher levels of Self-Regulated Learning tended to achieve better Academic Performance.
- A statistically significant positive relationship was found between Social Competence and Academic Performance among higher secondary school students ($r = .745, p < .001$), indicating that students with higher

levels of Social Competence tended to achieve better Academic Performance.

- Multiple regression analysis revealed that Self-Regulated Learning and Social Competence jointly and significantly predicted Academic Performance ($R^2 = .910, F(2, 1197) = 6023.698, p < .001$). Among the two predictor variables, Self-Regulated Learning emerged as the stronger predictor of Academic Performance.

Educational Implications of the Study

Based on the findings, it indicated that students' academic achievement in higher secondary school can be enhanced by enhancing their self-regulated learning and social competence. Based upon the results of this study, it appears that self-regulated learning is the most important factor influencing academic achievement. Therefore, educators should develop strategies supporting students' ability to establish personal goals for themselves and monitor their own learning processes along with effectively utilizing time management skills and reflection techniques so they may learn independently as efficiently as possible. Schools also require a learning environment that allows students to take ownership of their own learning as independent and lifelong learners.

This strong correlation between social competence and academic achievement further emphasizes the importance of developing programs that foster communication, collaboration, interpersonal relationships, empathy, problem solving skills within school curricula. Teachers, counsellors and planners should plan and implement programs or interventions that promote students' ability to self-regulate

and develop social skills. Similar projects may lead to improved performance not only in academics but also in the personal and social development of students.

The results also carry significant implications for teacher training courses. Teacher training programs and curriculum for prospective teachers should prepare them to teach students how to self-regulate their learning behaviour and develop the social skills necessary to interact with others positively. Training in learner-centred instructional strategies, reflective teaching, collaborative learning, classroom management and socio-emotional learning should be included in both coursework and teaching practice for teacher education programs. Preparation of future teachers to develop these competencies enables teacher education programs to contribute positively toward improved student learning outcomes and holistic development.

Limitations of the Study

- The study was confined to higher secondary school students in Idukki District, which may limit the generalisability of the findings.
- The cross-sectional design does not permit causal conclusions.
- Academic performance was measured only through board examination aggregate marks; other indicators such as classroom performance or continuous assessment were not considered.
- Social competence was assessed using an investigator-developed scale. Although it demonstrated acceptable reliability and validity, further validation with diverse populations is recommended.

- The study relied on self-report measures for self-regulated learning and social competence, which may be subject to response bias.
- The findings concerning the strong associations among the variables warrant careful interpretation, as the cross-sectional research design and dependence on self-report data may have introduced common method bias and consequently influenced the strength of the observed relationships.

Suggestions for Future Research

Future studies may:

- Future studies could adopt longitudinal research designs to investigate how these variables develop and change over time.
- Include students from other districts and states to improve generalisability.
- Investigate additional variables such as academic motivation, resilience, parental support, teacher support, emotional intelligence, and learning strategies.
- Explore mediating and moderating variables influencing academic performance.
- Compare government, aided, and private schools using advanced statistical techniques.

Conclusion

As evidenced in the present study, both self-regulated learning and social competence are important predictors of academic achievement among higher secondary school students. The study found that students with higher levels of self-regulated learning and social competence tend to perform better academically, with

self-regulated learning emerging as the stronger predictor. These results suggest that in addition to teaching academics, it is crucial to foster students' self-regulation ability and social skills. As a result, educational institutions need to implement student-centred practices and supportive interventions that promote these competencies in order to improve students' academic achievement and overall educational growth.

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TRANSFORMATIVE LEARNING THEORY ACROSS DISCIPLINES: A THEMATIC REVIEW

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Abstract

Jack Mezirow developed Transformative Learning Theory (TLT) starting in the late 70's and into the early 80's as a framework to explain 'how learners made perspective transformation' (Taylor, 2007). Over the years since its creation, Transformative Learning Theory has become one of the most researched theories of learning how to change perspectives. While originally stemming from research in adult education, transformative learning has been applied to research across different fields such as higher education, nursing and health professions education, teacher education, environmental and sustainability education, workplace and leadership development, and mathematics education to name a few. This thematic literature review explores the various key concepts within Transformative Learning Theory (TLT), such as disorienting dilemma, critical reflection, rational discourse, and perspective transformation and how they have been applied and interpreted within different fields of research. Instead of reviewing the literature by year of publication, as is typical of literature reviews, this paper will thematically review the literature by discussing similarities in application among various fields, key scholarly disputes, and variations of application among fields. Sources are drawn from the disciplinary literatures summarised in Tables 1 and 2 across seven thematic fields, comprising 28 references published between 1978 and 2025 and identified through Scopus, Web of Science, ERIC, Shodhganga, Semantic Scholar, and ResearchGate. Findings show that while there are many ways to facilitate transformative learning among various fields of study, they all typically include some sort of experience that alters assumptions, guided reflection, and discourse. At the same time, important tensions remain concerning the theory's adult-centred origins, its measurement, and the extent to which it adequately incorporates affective, embodied, and sociocultural dimensions of learning. By comparing applications across disciplines, this paper demonstrates both the adaptability of TLT and the continuing need for clearer models, validated tools, and context-sensitive implementation frameworks.

Keywords: *transformative learning theory, disorienting dilemma, critical reflection, thematic review, mathematical modelling*

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Introduction

Learning theories differ not only in how they explain the acquisition of knowledge but also in the kind of change they claim to produce. Behaviourist and cognitivist perspectives largely explain learning as the accumulation or restructuring of knowledge and skills. Transformative Learning Theory, by contrast, addresses a deeper form of change: the revision of the assumptions, beliefs, values, and frames of reference through which individuals interpret experience.

Jack Mezirow's original conceptualisation of the theory grew out of research on women returning to school and work. Mezirow claimed that learning would lead to transformation when assumptions are reflected upon critically, rather than taken for granted, and then either validated through the reflection process or changed to account for new experience. He distinguished between instrumental learning, which is focused on problem solving and task performance, and communicative learning, which is concerned with questioning and understanding meanings, values, and intentions through dialogue with others. Habermas's theory of communicative action provided grounding for the communicative aspect of transformative learning and discourse as a method of confirming that learners have revised their meaning perspectives. Over time, TLT has moved far beyond its original location in adult and continuing education. Researchers and practitioners have used it to design curricula, interpret learner development, and explain shifts in identity, values, and professional practice in diverse fields. This broad uptake has strengthened the theory's influence but has also generated

debates about its scope, coherence, and applicability across contexts.

This paper reviews Transformative Learning Theory thematically across disciplines. It first outlines the conceptual foundations of the theory, then examines its applications in higher and adult education, nursing and health-professions education, teacher education, environmental and sustainability education, workplace and leadership development, mathematics education, and formal schooling. It also includes summary tables of representative studies. Since teacher educators are the main readers of this journal, education is the thread that unifies the review: the other six areas are considered with respect to their implications for B.Ed. and M.Ed. programmes, and the review closes with a return to this audience in the Implications for Teacher Education and Practice section. The paper ends with a discussion of recurring themes and major theoretical debates.

Conceptual Foundations of Transformative Learning Theory

Transformative Learning Theory emerged from Mezirow's 1978 study of women re-entering community college programmes. From this work, he proposed that adults rely on meaning perspectives or frames of reference socially and personally shaped structures of assumptions through which they understand experience. These frames often remain implicit and unexamined until disrupted by experiences that cannot be easily accommodated.

A central concept in the theory is the disorienting dilemma, an event or experience that challenges an existing frame of reference. Such disruption may trigger

critical reflection, through which learners question previously taken-for-granted assumptions. Through rational discourse with others, learners test alternative interpretations and eventually arrive at revised perspectives. This process may culminate in perspective transformation, where new understandings are reintegrated into action and identity.

Mezirow later described transformative learning as unfolding through roughly ten phases, beginning with a disorienting dilemma and moving through self-examination, critical assessment of assumptions, recognition of shared experience, exploration of new roles, planning action, acquiring knowledge and skills, trying new roles, building competence, and reintegrating the revised perspective into life. Although these phases are often cited, researchers generally treat them as a heuristic rather than a rigid sequence.

The theory also distinguishes between instrumental learning, which focuses on problem solving and task performance, and communicative learning, which concerns interpreting meanings, values, and intentions through dialogue. Mezirow drew significantly on Habermas's theory of communicative action, emphasising the role of discourse in validating transformed meaning perspectives.

Despite its influence, TLT has never remained fixed. Later scholars have expanded, revised, and critiqued Mezirow's formulation, incorporating emotional, relational, spiritual, psychoanalytic, sociocultural, and neurobiological dimensions. As a result, TLT is now best understood not as a single uncontested model but as a broad theoretical tradition centred on perspective change through reflection and meaning reconstruction.

The table below summarises selected foundational and review oriented works that have shaped the development of Transformative Learning Theory.

Table 1

Representative Foundational and Review Literature on TLT

Author/Study	Year	Field/Context	Type of Work	Main Contribution
Mezirow	1978	Adult education	Foundational study	Introduced perspective transformation from research on women re-entering education
Mezirow & Associates	1990	Adult learning	Edited volume	Expanded transformative learning through critical reflection and emancipatory learning
Mezirow	1997	Adult and continuing education	Theory paper	Clarified theory to practice implications of transformative learning

Mezirow	2000	Adult learning	Book chapter	Defined core concepts such as frames of reference and transformation
Mezirow	2003	Adult learning	Theory paper	Emphasised discourse as central to transformative learning
Kitchenham	2008	Adult education	Review paper	Traced the evolution of Mezirow's theory over time
Wang, Torrisi-Steele, and Hansman	2019	Adult learning/critical theory	Conceptual paper	Linked critical theory and transformative learning
Hoggan	2023	Adult and continuing education	Review paper	Assessed the state of transformative learning theory after 45 years
McClain	2024	Adult education	Review paper	Surveyed recent developments and extensions in transformative learning

Thematic Review of Applications Across Fields

Higher Education and Adult Education

Transformative learning theory has found the most traction in higher education because adult learning was its original context. Within higher education, some scholars have used TLT both descriptively and prescriptively. Scholars using TLT descriptively aim to understand how learners are revising assumptions related to culture, identity, privilege, or professional purpose. Prescriptive uses of TLT attempt to create learning experiences that cause learners to change their frames of reference. Some common pedagogical approaches include the use of reflective journals, dialogic seminars, mentorship programmes, study abroad courses, service

learning or intercultural exchanges, social-justice-oriented pedagogy, and action research. These activities are meant to provide learners with opportunities to identify previously unexamined assumptions and then articulate their new perspective, often through dialogue with professors or peers. College campuses allow learners to question their beliefs and learn from discourse, which maps onto the theory's tenets quite well. The university context, with its relative openness to questioning beliefs and engaging in discourse, aligns closely with the theory's assumptions (Mezirow, 1997).

At the same time, scholars in this field frequently note that TLT has become conceptually diffuse. Numerous extensions emphasise identity, embodiment, spirituality, or social critique, leading

some authors to call for a meta theoretical framework capable of integrating these strands (Hoggan, 2023).

Nursing and Health-Professions Education

Nursing and health professions education is also one of the largest applied bodies of literature on TLT. Professional identity development, cultural competence, ethical sensitivity, developing a capacity to reflect on one's experiences, and leadership skills are just a few areas where scholars have applied the tenets of transformative learning (Tsimane & Downing, 2019, 2020). Clinical simulations, debriefings, and other case-based activities tend to align well with TLT because simulations can serve as the disorienting dilemma that places learners in a situation of uncertainty, ethical ambiguity, or unpredictability. Debriefing then provides an opportunity to reflect on these experiences in a structured way (Briese et al., 2020). Transformation in this field is often paired not only with knowledge acquisition but also with becoming a different kind of practitioner.

However, the literature also identifies recurring weaknesses. Although many studies invoke transformative learning conceptually, fewer provide detailed instructional frameworks or robust tools for measuring transformation. As a result, claims of transformative outcomes are sometimes based on self-report or inferred changes rather than standardised assessment (Ryan et al., 2022).

Teacher Education and Reflective Practice

Teacher education has long emphasised reflection, making it a natural site for TLT. Scholars use transformative

learning to explain how pre service and in-service teachers move beyond uncritical reproduction of inherited teaching models toward more reflective, equitable, and responsive professional practice (Kramer, 2018).

In this field, transformative triggers often include practicum experiences, intercultural encounters, classroom dilemmas, collaborative reflection groups, critical autobiographical writing, and exposure to alternative pedagogies. Reflection is frequently framed as the mechanism through which teachers interrogate assumptions about learners, teaching authority, curriculum, and social difference.

Teacher education research also highlights the importance of supportive dialogue. Transformative learning is less likely to occur when reflective activities are isolated, superficial, or reduced to compliance tasks. The quality of community matters: psychologically safe, dialogic environments better support perspective change than fragmented or highly instrumentalised training settings (Arvanitis, 2018).

Environmental and Sustainability Education

Environmental and sustainability education has widely embraced the language of transformation. In this field, TLT is used to explain shifts in worldview related to ecological responsibility, sustainability, interdependence, and environmental action.

Learning experiences in this area often involve place-based education, community engagement, experiential outdoor learning, sustainability projects, and critical engagement with environmental

crises. These experiences may challenge anthropocentric assumptions, consumerist habits, or perceptions of human-nature relationships, thereby functioning as disorienting dilemmas (Birdsall, 2025).

A key debate in this field concerns the meaning of transformation itself. Some scholars emphasise empowerment, critical consciousness, and autonomous judgment, whereas others focus more directly on behaviour change toward sustainable practices. This tension raises an important question: is transformative learning about independent perspective revision, or can it be used instrumentally to promote predetermined social goals? The field continues to wrestle with that issue (Singer-Brodowski, 2023; O'Grady, 2023).

Workplace, Human Resource Development, and Leadership

In workplace and organisational settings, TLT has been applied to leadership development, professional growth, mentoring, coaching, and career transition. The theory is especially relevant where organisations require more than technical up skilling and instead seek shifts in mind set, adaptability, judgment, and identity (Brooks, 2004).

Typical transformative mechanisms include cross-functional assignments, coaching conversations, journaling, leadership retreats, outdoor learning, mentorship, and exposure to unfamiliar organisational challenges. These experiences may unsettle habitual ways of thinking and invite employees to reinterpret their role, assumptions, and leadership style.

Yet compared with formal education, workplace learning poses challenges for

TLT. Reflection often competes with productivity demands, and organisational cultures may not always support open critical discourse. As a result, while transformative learning is conceptually attractive in human resource development, its implementation may be uneven (Brooks, 2004).

Mathematics Education

Mathematics education is a smaller but increasingly visible site of TLT application. Much of this literature focuses on teachers or prospective teachers rather than students. Researchers have used TLT to explain how mathematics teachers revisit assumptions about what it means to understand mathematics, how students think mathematically, and how mathematical knowledge should be taught (Johnson & Olanoff, 2020).

In teacher education, disorienting dilemmas may occur when learners discover that procedures they thought they understood lack conceptual depth, or when they encounter student reasoning that challenges deficit based assumptions. Inquiry-based mathematics, collaborative problem solving, and structured reflection have also been linked to transformative experiences, particularly in relation to confidence, empowerment, and epistemic beliefs (Hassi & Laursen, 2015; Peters & White, 2022). Compared with other fields, however, mathematics education still has a relatively small body of explicitly TLT-based research. It remains an emerging area in which the theory is used less frequently than sociocultural, constructivist, or problem-based approaches. Nevertheless, the literature suggests that transformative learning can illuminate how mathematical understanding involves not only skill acquisition but also changes in identity,

agency, and ways of knowing (Scheiner, 2025).

Formal K-12 Schooling

One of the most debated extensions of TLT concerns its applicability to school-age learners. Because Mezirow theorised transformative learning primarily in relation to adults, researchers have questioned whether younger learners possess the same degree of autonomy, reflexivity, and discursive capacity assumed by the theory.

The recent research suggests that transformation can occur in formal education settings, but that it is often developmental in nature. In other words, students might engage in critical reflection but at more simplistic stages appropriate to their ages and levels of maturity. The

focus of transformation in school settings is different; it is more on questioning, taking on multiple points of view, talking to each other, and discussing issues and meanings. In K-12 contexts, transformation seems to be less advanced, more dependent on others' ideas, and more guided than it is in adults (Kuriakou, 2023).

This extension is theoretically important because it tests the boundaries of the theory. It also invites rethinking whether transformation must always mean deep, fully articulated perspective revision, or whether less dramatic but still significant shifts in understanding should also count.

The following table groups selected studies and sources by field to show how TLT has been used across disciplines.

Table 2
Representative Studies by Field

Author / Study	Year	Field	Focus/ Application of TLT	Key insight
Mezirow	1978	Adult education	Perspective transformation in women re-entering education	Established the original theory
Mezirow	1997	Adult education	Theory-to-practice framework	Clarified transformative learning processes
Hoggan	2023	Adult education	45-year review of TLT	Highlighted theoretical diversification and lack of unified meta theory
Rojo et al.	2023	Nursing/health professions	Scoping review of curricular use	TLT widely used for reflection, identity, and professional growth

Ryan et al.	2022	Nursing/health professions	Umbrella review	Found broad uptake but inconsistent outcome measurement
Tsimane and Downing	2019	Nursing education	Concept analysis	Clarified antecedents, process, and outcomes of TLT in nursing
Tsimane and Downing	2020	Nursing education	Model development	Proposed a facilitative model for transformative learning
Kramer	2018	Teacher education	Reflective practice and teacher agency	Positioned reflection as a transformative disposition
Arvanitis	2018	Teacher education	Reflective and transformative pre service learning	Connected reflexivity to teacher development
Birdsall	2025	Sustainability education	Handbook chapter	Explained worldview change toward sustainability
Singer-Brodowski	2023	Sustainability education	Beyond formal learning	Extended TLT to informal and transition contexts
O'Grady	2023	Sustainability education	Faculty perspective	Linked pedagogy to transformative sustainability aims
Brooks	2004	Human resource development	TLT implications for HRD	Connected transformation to workplace learning
Johnson and Olanoff	2020	Mathematics teacher education	Relearning mathematics content	Used TLT to challenge assumed mathematical understanding

Peters and White	2022	Mathematics education	Teacher learning trajectory	Interpreted modelling learning through transformative phases
Hassi and Laursen	2015	Mathematics education	Undergraduate mathematics learning	Linked inquiry and collaboration to empowerment
Scheiner	2025	Mathematics teacher education	Strength-based noticing	Showed frame shifting in teacher perception
Kuriakou	2023	K-12 schooling	School-based synthesis	Argued for cautious, scaffolded extension to school settings

Cross-Field Synthesis: Recurring Themes

A thematic comparison across fields reveals several recurring patterns.

1 Disruption, Reflection, and Dialogue as Common Mechanisms

Across disciplines, transformative learning consistently begins with some form of disruption. Whether the setting is a clinical simulation, intercultural exchange, environmental immersion, workplace challenge, or mathematics inquiry, learners encounter an experience that unsettles habitual assumptions. They then mediate that disruption through reflection and dialogue.

2 Reflection Is Central but Not Uniformly Defined

Although nearly all applications emphasise reflection, the term does not mean the same thing everywhere. In some studies it refers to individual journaling; in others, to collaborative dialogue, metacognition, ethical deliberation, or identity work. This conceptual variation partly explains why the

literature sometimes struggles to compare findings across fields.

3 TLT Is Highly Portable but Contextually Adapted

The broad adoption of TLT suggests that its core ideas are portable across disciplines. Yet each field adapts the theory to its own aims. Nursing emphasises professional identity and care ethics; sustainability education emphasises ecological worldview and action; teacher education emphasises reflective practice; workplace learning emphasises leadership and adaptability; mathematics education emphasises conceptual reframing, agency, and empowerment.

4 Operationalisation Remains a Persistent Weakness

A recurring criticism across fields is the gap between theory and implementation. Many studies invoke TLT as a conceptual frame but provide limited detail on how transformation is intentionally designed,

scaffolded, or measured. Concrete models, validated instruments, and replicable protocols remain underdeveloped in much of the literature.

5 Adult-Centred Origins Continue to Shape the Theory

Even where TLT is extended into new fields, its adult-learning origins remain

visible. The theory assumes a degree of self-awareness, critical autonomy, and discursive participation that may not be equally available in all contexts. This is especially relevant in K-12 education but also matters in hierarchical workplaces or culturally constrained settings where open critique may be difficult.

Table 3

Core Elements of TLT and Their Typical Pedagogical Forms Across Fields

Core TLT Element	Meaning in Theory	Typical Pedagogical Forms Across Fields
Disorienting dilemma	Experience that disrupts prior assumptions	Clinical simulation, study abroad, ethical dilemma, modelling task, workplace challenge, environmental immersion
Critical reflection	Examination of beliefs and assumptions	Journals, reflective essays, autobiographical writing, debriefing, guided questioning
Rational discourse	Testing interpretations through dialogue	Seminars, peer discussion, mentoring, collaborative groups, reflective conferences
Perspective transformation	Revision of frame of reference	Changed professional identity, altered teaching beliefs, ecological worldview shift, strengthened mathematical agency
Reintegration into practice	Acting on revised understanding	Classroom application, clinical practice, leadership behaviour, sustainability action, new learning strategies

Critiques and Theoretical Debates

Transformative Learning Theory has generated substantial debate alongside its widespread influence.

One longstanding critique is that the theory is overly rationalistic. Early formulations privileged conscious critical reflection and discourse, leading critics

to argue that emotion, embodiment, imagination, intuition, and the unconscious were insufficiently addressed. Later scholarship has broadened the theory, but the tension remains.

A second critique is that TLT is too individualistic. Much of the literature focuses on transformation within the learner, sometimes underemphasising social

structures, power relations, and collective forms of change. This has led sociocultural and critical scholars to ask whether transformation should be understood not only as personal perspective change but also as social and political action.

A third debate concerns conceptual fragmentation. Over time, TLT has developed cognitive-rational, psychoanalytic, sociocultural, spiritual, critical, and neurobiological variants. This diversity reflects intellectual vitality, but it also makes the theory harder to define with precision. Some scholars see this plurality as a strength; others view it as evidence that the field needs stronger theoretical integration.

A fourth issue concerns measurement. Transformation is difficult to observe directly, and many studies rely on retrospective self-report, reflective writing, or qualitative inference. While these methods are useful, they make it difficult to compare studies or determine the extent of change across contexts.

Implications for Understanding TLT Across Disciplines

TLT is inconsistently applied across disciplines at the same time. This suggests that not only are desired outcomes different, but also practices and underlying assumptions. As such, usefulness of the theory may hinge less on adherence to any one prescribed model, and more on adaptation of its principles as a framework through which to view disorientation, reflection, dialogue, and shifting perspective in certain contexts. Directions for future research may prove most fruitful if they offer more clearly defined operational models, robust assessment of transformation, greater

emphasis on affective and sociocultural elements, and additional inquiry into travel of the theory across generations and cultures.

Implications for Teacher Education and Practice

For teacher educators, the cross-field synthesis suggests several concrete takeaways. As in nursing education, teacher preparation programmes can use structured, debriefed experiences practicum placements, case dilemmas, and critical incident analysis as deliberate disorienting dilemmas rather than leaving reflection to chance (Kramer, 2018). As in sustainability education, teacher educators can pair reflective writing with guided dialogue so that critical reflection is not treated as an isolated, individual task but is validated through discourse with peers and mentors. As in workplace and leadership development, B.Ed. and M.Ed. programmes can build in structured mentoring and coaching conversations that help pre-service and in-service teachers reinterpret their assumptions about learners, curriculum, and authority (Brooks, 2004). Finally, the mathematics education literature indicates that TLT-informed instructional design can support teachers in revising assumptions about mathematical understanding itself a direction relevant to programmes developing mathematical modelling and pedagogical-content-knowledge courses for prospective teachers (Johnson & Olanoff, 2020).

Limitations

This review has limitations that should be considered when interpreting its findings. It follows a thematic, non-systematic search approach rather than a fully documented

systematic-review protocol, drawing on sources identified through Scopus, Web of Science, ERIC, Shodhganga, Semantic Scholar, and ResearchGate. As with any thematic synthesis, the selection and grouping of studies reflects the reviewers' interpretive judgment rather than an exhaustive, protocol-driven search of the literature. The review is also limited to English-language publications, thus excluding relevant scholarship published in other languages. Furthermore, the precise search terms used are not available to the reader, and the number of sources that were initially screened against inclusion and exclusion criteria are not specified in the manuscript. Updates to this review will systematically document these considerations.

Conclusion

Transformative Learning Theory has proven to be one of the most adaptable and influential frameworks in contemporary educational thought. From its origins in adult re-entry education, it has expanded into higher education, health-professions education, teacher development, sustainability education, workplace learning, mathematics education, and formal schooling. Across these domains, the theory consistently centres on disruption of assumptions, critical reflection, dialogue, and perspective change.

Thematic analysis across fields shows both continuity and variation. TLT retains a recognisable conceptual core, yet each discipline reshapes it according to its own purposes and conditions. This flexibility helps explain the theory's longevity, but it also contributes to debates about coherence, implementation, and measurement.

Overall, the literature demonstrates that transformative learning remains a powerful lens for understanding profound forms of learning across disciplines. Its continued relevance depends not only on preserving its core insights but also on refining its methods, clarifying its constructs, and adapting it thoughtfully to diverse educational and professional settings.

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ENTREPRENEURIAL APTITUDE AMONG STUDENTS: DOES STREAM OF STUDY MATTER?

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Abstract

To foster entrepreneurial culture among youth, it is vital to understand and promote the aptitude of students towards entrepreneurship. How our education system meets this objective is a question is not fully addressed. This research attempted to explore the seminal component of entrepreneurship by analysing the interview data of students and to measure the level of entrepreneurial aptitude among students by analysing the data which were collected using a questionnaire. The study adopted a mixed-methods, exploratory sequential design and collected data from higher secondary students, including 30 Commerce students and 30 Science students. Descriptive statistics, independent t-test and thematic analysis were employed to analyse the collected data. Commerce and Science students showed moderate entrepreneurial aptitude across different dimensions, although many students expressed the need for better institutional support, mentorship, and practical exposure. The commerce and science students differ in their level of entrepreneurial aptitude. The findings indicated that students generally possessed a positive entrepreneurial aptitude, and it also found that financial independence and successful entrepreneurs were major motivating factors for entrepreneurship, whereas lack of capital and fear of failure are the major barriers to entrepreneurship. The study concludes that entrepreneurship education plays a significant role in shaping students' entrepreneurial aptitude. It emphasises the need for educational institutions to provide effective entrepreneurship programs, skill-based learning opportunities, and guidance to encourage students to pursue entrepreneurship as a career option.

Keywords: entrepreneurship, entrepreneurial aptitude, risk-taking, networking and team building

Introduction

The national progress and individual development can be instrumented

by education (Bohara et al., 2026). Education is not only for acquisition of academic knowledge, but it also aims

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development of critical thinking, leadership abilities, innovative attitude, scientific temper, problems solving skills etc. The competencies in these aspects really enable a learner to respond effectively and efficiently to dynamic environment and ever-changing social conditions and it prepares them for diverse career opportunities. Entrepreneurial education, in so far, foster these competencies among students at a budding stage. It prepares youngsters not only to seek employment in future but also to become creators of employment.

Entrepreneurship is largely accepted as a weapon for economic growth, technological advancement and social development (Haugh and Talwar, 2016). It is the process of identifying opportunities, organising resources, calculating and bearing risk and creating value through innovation and transformations. The relationship between growth and entrepreneurship, in its various dimensions, are referred in many academic work and policy papers. Entrepreneurs stimulate economic development (Schumpeter, 1934) and entrepreneurship as the key ingredients fuelling economic growth (Audretsch, 2018), entrepreneurship foster inclusive growth (Ajide et al., 2021) are some of the scholarly works that states the importance of entrepreneurship and development.

How entrepreneurial attitude can be fostered and entrepreneurship can be achieved is not a recent point of discussion. Many scholars and leaders viewed the importance of education in building entrepreneurial attitude. Drucker (1985) was of the opinion that entrepreneurship as a discipline that can be learned and developed through education and experience. Educational institutions can perform an

important role in cultivating entrepreneurial aptitude among students from an early stage. The National Education Policy (NEP, 2020) emphasises the integration of skill-based learning, innovation, experiential education, and entrepreneurship across different levels of education. It encourages educational institutions to nurture creativity, self-reliance, and problem-solving abilities so that learners become job creators rather than job seekers. In this context, entrepreneurship education has become increasingly significant at the higher secondary level, where students begin making important academic and career decisions.

Students from different academic streams may develop entrepreneurial aptitude through different educational experiences. Commerce students are generally exposed to subjects such as Business Studies, Accountancy, Economics, and Marketing, which provide knowledge of business operations, financial management, and entrepreneurial concepts. In contrast, Science students acquire analytical thinking, scientific reasoning, creativity, experimentation, and technological problem-solving skills that are equally valuable for entrepreneurship, particularly in innovation-driven and technology-based enterprises. Therefore, differences in academic background may influence the development of entrepreneurial aptitude among students.

Although several studies have examined entrepreneurship education, entrepreneurial intention, and entrepreneurial skills among students, relatively few studies have compared entrepreneurial aptitude between Commerce and Science students at the higher secondary level. Existing research

mainly focuses on university students or business students, leaving limited evidence regarding how academic stream influences entrepreneurial aptitude during higher secondary education. This gap highlights the need for a comparative study that examines whether students' academic background contributes to differences in entrepreneurial aptitude.

Curriculum designers and policy makers are always expecting research finding in the field they actually engage to. This research may provide insights to teachers, school personnels and curriculum makers towards why entrepreneurial education is important at an early stage of their formal education and how it should be designed and executed in schools.

The present study therefore aims to examine the entrepreneurial aptitude of Commerce and Science students and to determine whether academic background influences entrepreneurial mindset and entrepreneurial skills. The findings of the study are expected to contribute to entrepreneurship education by providing insights for curriculum development, educational policy, and classroom practices that promote entrepreneurial competencies among higher secondary students.

Literature review

The review of literature provides the theoretical and empirical foundation for the present study by examining previous research related to entrepreneurship, entrepreneurial aptitude, and entrepreneurship education. It helps to identify existing knowledge, research gaps, and the need for further investigation.

Entrepreneurship has been explained from different theoretical perspectives.

Cantillon (1931) regarded entrepreneurs as individuals who undertake risk under conditions of uncertainty. Schumpeter (1934) considered entrepreneurs to be innovators who introduce new products, services, and methods that stimulate economic development. Drucker (1985) argued that entrepreneurship is not merely an inborn talent but a discipline that can be developed through education, training, and experience.

Recent empirical studies have highlighted the importance of entrepreneurship education (Jain et al., 2017; Nabi et al. 2017; Rauch and Hulsink, (2015) in developing entrepreneurial aptitude among students (Jain and Arora, 2020; Arthur and Arthur, 2020). Many scholarly works reported that entrepreneurship education enhances creativity (Berlinguer, 2012), innovation (Mayhew et al., 2012), and entrepreneurial competence. Kindel and Stevens (2021) emphasised that educational institutions play a significant role in developing entrepreneurial thinking through curriculum and institutional support. Similarly, Akabuike (2022) found that financial independence, self-employment opportunities, and personal achievement are important motivational factors influencing students' entrepreneurial aspirations.

Studies have also identified several personal and environmental factors influencing entrepreneurial aptitude. Khedhaouria et al. (2015) reported that creativity and entrepreneurial orientation positively influence entrepreneurial performance, whereas Priyadarshini et al. (2025) highlighted the importance of self-confidence and critical thinking in promoting entrepreneurial intention.

Research further indicates that supportive family environments (Coppens and Knockaert, 2022; educational experiences (Kolstad and Wiig, 2015; Konczol, 2004) mentorship (Waters, 2002), and institutional guidance significantly contribute to students' entrepreneurial development.

Although previous studies have examined entrepreneurship education and entrepreneurial intention, comparative studies investigating entrepreneurial aptitude between Commerce and Science students remain limited, particularly at the higher secondary level. The present study attempts to address this research gap by comparing entrepreneurial aptitude across the two academic streams.

Objectives

- To measure the level of Entrepreneurship aptitude among commerce and science students
- To examine whether academic background (commerce and science) influence the entrepreneurial mindset and skills

Methodology of the study

The research follows explorative sequential design (Creswell, 2012) since it aims to derive the components of entrepreneurship from interview transcript of the participants and to measure the entrepreneurial aptitude of students by statistical analysis of quantitative data collected by questionnaire. The component of entrepreneurship is derived from thematic analysis of data which are collected from rigorous literature review and interview with students. The entrepreneurial aptitude is described by using descriptive statistics such as mean and standard deviation and the mean difference between sample is

analysed by using t test. The interpretations derived from qualitative and quantitative analysis shown separately.

Sample

The researchers collected the perspectives of business and science students regarding the components which influence entrepreneurial decisions and aptitude. A total of ten students were interviewed, five from both commerce and science stream.

The present study was conducted among higher secondary students belonging to Commerce and Science streams. A total of 60 students were selected as the sample for the

Table 1

Analysis of sample in terms of Streams

Streams	Number of students	Percentage
Commerce	30	50%
Science	30	50%

study, out of which 30 students were from the Commerce stream and 30 students were from the Science stream. The present study adopted the cluster sampling technique for selecting the sample. The total population was first divided into two strata based on the academic stream, namely Commerce and Science. From each stratum, an equal number of students were selected randomly to ensure adequate representation of both streams. Since the nature of samples are homogeneous throughout the state of Kerala, the researcher selected samples only from two districts of Kerala, Kannur and Kasargod.

Table 1 shows the distribution of the sample according to the stream of study.

The total sample consists of 60 students, of which 30 students (50%) are from the Commerce stream and 30 (50%) are from the Science stream. The equal representation of students from both streams ensures balanced comparison and helps in obtaining unbiased and reliable results of the study.

The details of the distribution of the sample obtained for the study are presented in Figure 2.

Figure 2 shows the gender-wise distribution of students in terms of stream

of study. In the commerce stream, 7 students (11.67%) are boys, and 23 students (38.33%) are girls. In the science stream, 14 students (23.33%) are boys, and 16 students (26.67%) are girls. The distribution indicates a higher representation of girls in the commerce stream, while the science stream shows a comparatively balanced representation of boys and girls. This balanced distribution across streams and gender helps in making meaningful comparisons and ensures unbiased results of the study.

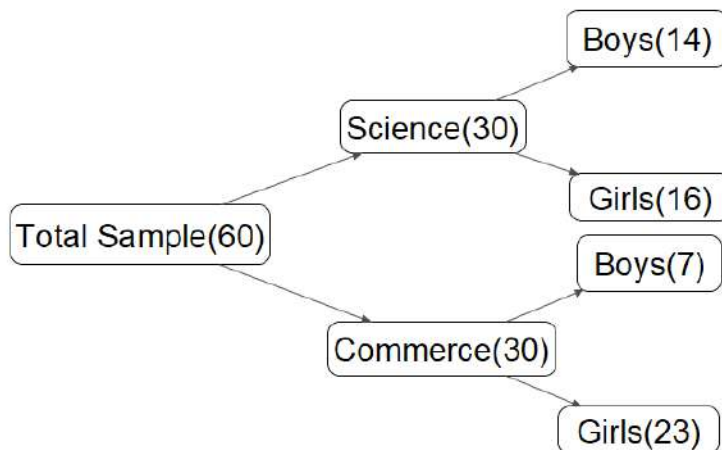


Figure 1 Final samples

Tool and procedure of data collection

Data were collected using a structured questionnaire prepared by the investigator to measure entrepreneurial aptitude among commerce and science students. The questionnaire was administered through an online survey using Google Forms. A total of 60 responses were collected, including 30 commerce students and 30 science students. The data collected was carefully compiled and organised for further analysis

and interpretation. The face validity of the tool was ensured by obtaining expert opinion in the field. The interview protocol is prepared by using the components which were derived from literature review.

Analysis and Discussions

Underpinning to Literature

Analysis of current literature reveals that there are mainly six components (figure 1) that defines entrepreneurship in so far. They are:

A) Informed decision-making capacity at individual level

It refers to the ability to collect relevant information, evaluate available alternatives, and make thoughtful and rational choices. Businesspeople take decisions based on data.

B) Risk taking

It refers to the willingness to face uncertainty and challenges while pursuing

goals. It includes the ability to accept possible failure, manage ambiguity, and take calculated risks in order to achieve desired outcomes.

C) Need for achievement and goal setting

It reflects a strong desire to excel, accomplish challenging tasks, and attain personal success. Individuals with a high need for achievement prefer responsibility, goal-oriented activities, and opportunities for self-improvement.

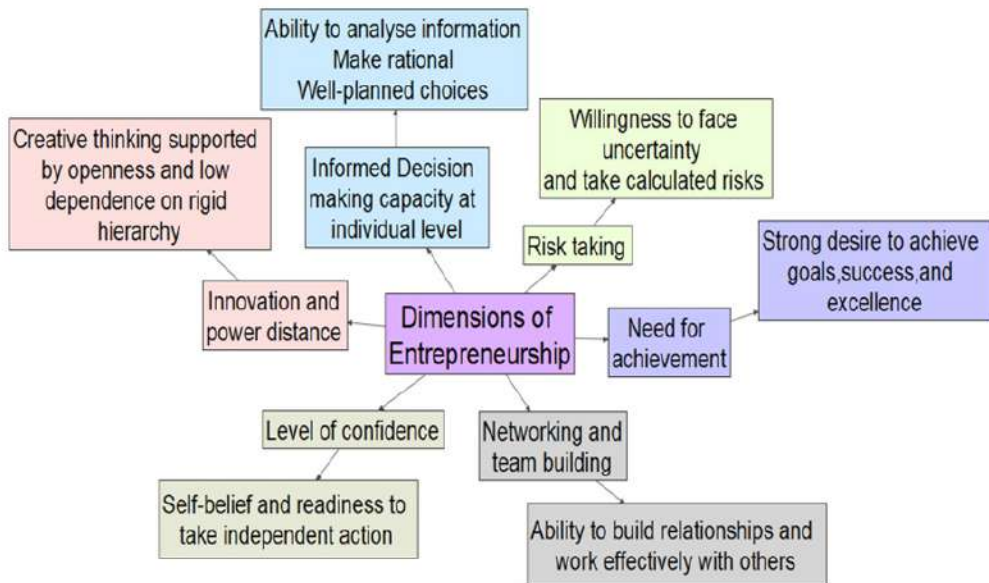


Figure 2 Dimensions of Entrepreneurship

D) Networking and team building

It refers to the ability to establish relationships, collaborate with others, and work effectively in groups. It involves communication skills, cooperation, and the capacity to build supportive connections for achieving common objectives.

E) Level of confidence and initiative

It refers to self-belief and the willingness to take proactive action. This dimension includes independence, leadership, and the ability to take the first step without external pressure.

F) Innovative and power distance

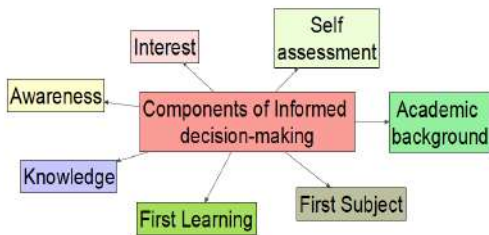
It refers to the ability to generate new ideas and creative solutions, while power distance reflects attitudes toward authority and hierarchy. A lower acceptance of rigid hierarchy encourages independence, creativity, and open expression of ideas.

Entrepreneurship: Component wise analysis

The subcomponents of entrepreneurship on each dimension as attributed by students are depicted in figure 2. The major dimensions which were identified from the literature review are: informed decision making, risk taking, need for achievement, networking and team building, level of confidence and innovative and power distance. The researcher reached the subcomponents by visiting the interview transcript over many times and certain

patterns are identified from the data and these are developed as codes and themes. These themes and codes are presented as subcomponents of entrepreneurship.

The qualitative analysis of the study revealed that both commerce and science students show a positive inclination towards entrepreneurship. The analysis of interview transcript revealed that commerce students generally possess better knowledge of business concepts such as finance, marketing, and management due to their academic curriculum, which helps them understand entrepreneurial processes more clearly. On the other hand, science students demonstrate strong analytical ability, creativity, and problem-solving skills, which are valuable for innovation-driven and technology-based ventures. This indicates that entrepreneurship is not limited to any single academic stream.



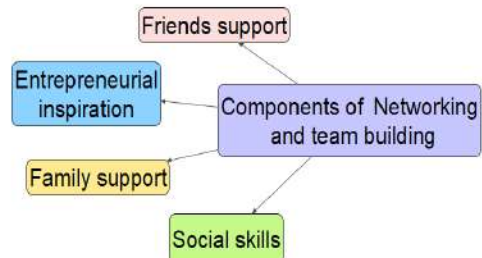
Informed decision-making



Risk taking



Need for achievement



Networking and team building

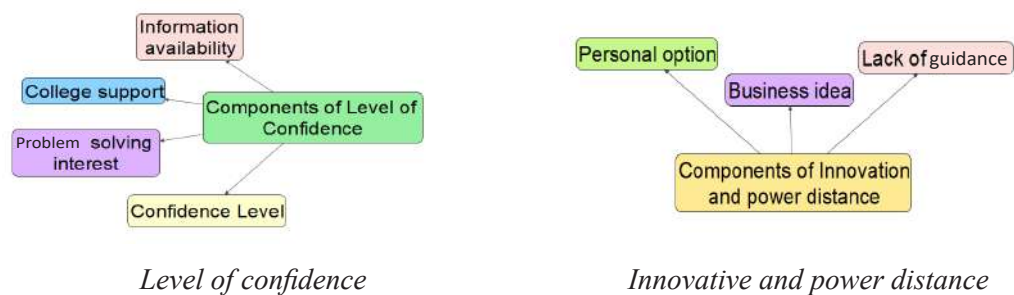


Figure 3: component wise distribution of entrepreneurship

Mean and Standard deviation computed among students

Table 2
Mean and standard deviation were computed for the total sample (N=60)

Statistical indices	Total sample	Gender wise		Streams	
		Boys	Girls	Science	Commerce
Mean	9.88	10.02	9.77	10.18	9.55
Standard deviation	3.50	3.38	3.64	3.42	3.64

From table 2 it is understood that mean and SD for total sample are found to be 9.88 and 3.50 respectively. The total score for the test was 22. So, it can be concluded that the aptitude for entrepreneurship of higher secondary students is not satisfactory since the average score below the expected level of entrepreneurial aptitude, which is at least 50%, 11. The SD of the score of entrepreneurial aptitude for the total sample is 3.50. The students have same level of entrepreneurial trait irrespective of gender, but it is different according to stream of study.

Difference on entrepreneurial aptitude

Mean difference in entrepreneurial aptitude based on gender

From the table 3, mean and standard deviation for entrepreneurial aptitude of boys and girls were found to be 10.02 and 3.38 and 9.77 and 3.64 respectively. The girl's score is more deviated from the mean score since they have higher standard deviation compared to boys. The analysis of 't' value (p-value 0.141) shows that there exists no significant difference for the variable entrepreneurial aptitude between boys and girls. Boys and girls have no significant difference regarding entrepreneurial potential.

Table 3
Comparison of the Entrepreneurial Aptitude for the Subsample Based on Gender

Gender	Sample size	Mean	SD	t value	p-value	Level of Significance 5%
Boys	30	10.02	3.38	1.49	0.141	NS
Girls	30	9.77	3.64			

Mean difference in entrepreneurial aptitude based on stream of study

Table 4

Comparison of the Entrepreneurial Aptitude for the Subsample Based on stream of study

Stream of study	Sample size	Mean	SD	t value	p-value	Level of Significance 5%
Commerce	30	9.53	3.64	3.72	0.00045	Significant
Science	30	10.16	3.42			

From table 4, mean and standard deviation of the entrepreneurial aptitude of subsample based on stream of study, commerce and science, were found to be 9.53 and 3.64 and 10.16 and 3.42 respectively. It can be concluded that the entrepreneurial aptitude of science students is comparatively higher than the students from commerce stream.

The analysis of 't' value (3.72) and p-value (0.00045) shows that there exists significance difference at 0.05 level for the variable entrepreneurial aptitude between commerce and science students. The entrepreneurial aptitude between commerce and science students has significant statistical difference.

From the analysis it can be concluded that the entrepreneurial potential of students is not satisfactory and not come to the desired level. The entrepreneurial there is significant difference in the entrepreneurial aptitude of students based of stream of study.

Conclusion

The present study titled "Entrepreneurial Aptitude among Students: Does Stream of Study Matter?" aimed to identify the factors influencing their motivation and challenges in pursuing entrepreneurship and to know the level of entrepreneurial aptitude among students.

The study also shows that factors such as financial independence, personal interest, innovation, and the desire to be self-reliant motivate students to consider entrepreneurship as a career. However, several barriers such as lack of financial resources, fear of failure, insufficient practical knowledge, and limited institutional support discourage students from taking entrepreneurial initiatives. The entrepreneurial aptitude for total sample is not desirable. And there is statistical difference in the entrepreneurial aptitude of commerce and science students.

The findings have a significant implication for teacher education programmes. Teacher educators can play a crucial role in developing entrepreneurial aptitude among higher secondary students by equipping prospective teachers with the knowledge, skills, and pedagogical strategies required to promote entrepreneurship in the classroom. The findings of the study reveal the importance of integration of entrepreneurship education through project-based learning, problem solving approaches, innovative attitude etc. Such attempt and initiatives will enable future teachers to foster entrepreneurial thinking, creativity, self-confidence, and leadership qualities among students, thereby preparing them for self-employment and sustainable career opportunities.

Overall, the study concludes that commerce and science students possess considerable entrepreneurial potential. With proper guidance, skill development programs, mentorship, and institutional support, students can transform their interest into successful entrepreneurial ventures. Encouraging entrepreneurship education within academic institutions will not only benefit students' career development but also contribute to economic growth and innovation in society.

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TEACHERS' PERSPECTIVES ON INNOVATIVE TECHNOLOGY INTEGRATION IN HIGHER EDUCATION: EVIDENCE FROM KERALA

Geethu T. G.* & Prof. (Dr.) Sajna Jaleel**

Abstract

*In contemporary Higher Education, the role of innovative digital technologies has become vital nowadays. It allows and enhances a flexible learning environment and instructional effectiveness. But there is variation in adopting and effectively integrating these technologies among teachers. The present study tries to examine teachers' perspectives towards effective technology integration in higher education in Kerala, India. A quantitative survey is used for the study, and data from 356 faculty members were collected using a structured questionnaire consisting of 44 items. The result of Cronbach's alpha ($\alpha = 0.87$) confirmed the reliability of the instrument. To analyse the results Descriptive Statistics, Independent sample *t* test, one way analysis of variance (ANCOVA) with Tukey post hoc comparisons were done using SPSS.*

The findings of the study show that teachers generally have a positive attitude towards technology integration, and they frequently use technology such as digital tools, video conferencing platforms, learning management systems, and assessment tools. Even though they are familiar with and use these technologies, they face barriers including inadequate institutional support, insufficient professional training and restricted access. So the study points to the importance of continuous professional development, institutional support mechanisms, and policy initiatives to increase technology integration in education.

Keywords: Technology Integration, Digital Learning, Innovative Technology

Introduction

The current teaching and learning practices have got significantly

transformed due to the developments of digital technologies. To enhance the instructional effectiveness and student

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engagement, institutions have adopting learning management systems and digital platforms including interactive multimedia. Technology integration in education refers to the meaningful incorporation of digital technologies into pedagogical practices to support learning outcomes and the quality of instruction. To promote a flexible learning environment and improve teaching effectiveness, we can consider innovative technologies in various forms. It fosters collaboration, critical thinking and problem-solving skills. So we should consider innovative technology as the key component of contemporary higher education.

Even though the technology is developing day by day its implementation in education field completely depends on teachers' attitude, technological competencies and the support from institution. And teachers' role is so crucial in determining the extent of integrating technology to support learning. So the study suggests that teachers' perceptions, their needs, and the limitations they face should be analysed and considered for the future. There are numerous studies which examines the technology integration in education. But empirical research focusing on teachers' perspectives in regional contexts remains limited. The research gap led to the present study which examines how higher education teachers in Kerala perceive and implement innovative technologies in their teaching practices.

Need and Significance of the Study

Teachers' perspectives towards technology, their professional competencies, and their day-to-day working conditions are shaped by their environment and ecosystem

(Doğan et al., 2021). So, understanding teachers' viewpoints from within this specific context allows researchers and administrators to pinpoint the particular obstacles preventing Kerala's higher-education teachers from incorporating technology into their teaching. It helps to design locally relevant strategies to overcome them (Earle, 2002). It should be acknowledged that technology has the potential to significantly expand educational opportunities. Policymakers and administrators also need to recognise that teachers require adequate time to incorporate technology into the classroom. since doing so involves preparation, the learning of new skills, and revised lesson planning. Ultimately, sustainable technology integration depends on striking a balance between traditional and technology-assisted teaching methods (Schul, 2014). The present study aims to examine region specific empirical evidence and there by enhance the technology integration in higher education.

Theoretical Framework

The theoretical foundation of the study is provided by the Technological Pedagogical Content Knowledge (TPACK) and the Technology Acceptance Model (TAM). It is used to interpret the results.

Technological Pedagogical Content Knowledge (TPACK)

The TPACK framework, proposed by Mishra and Koehler (2006), emphasises the integration of three essential components of teacher knowledge such as:

- Technological knowledge
- pedagogical knowledge
- content knowledge

According to this framework, effective technology integration occurs when teachers develop the ability to combine these three forms of knowledge in meaningful ways. Teachers who possess strong TPACK competencies will be better able to design technology-supported learning environments (Chai et al., 2019). It enhances student learning outcomes. Recent studies highlight the importance of TPACK in promoting effective technology integration in higher education. Teachers with higher levels of technological and pedagogical knowledge are more likely to implement innovative teaching practices using digital tools (Howard et al., 2021).

Technology Acceptance Model (TAM)

Davis (1989) proposed the Technology Acceptance Model. It explains how users adopt and utilise new technologies based on two primary factors. They are perceived usefulness and perceived ease of use. In educational contexts, teachers' acceptance of technology significantly influences their willingness to integrate digital tools into teaching practices (Scherer et al., 2019). Recent research has demonstrated that teachers' perceptions of technology usefulness, institutional support, and training opportunities significantly influence their adoption of digital technologies in education (Al-Adwan et al., 2013).

By integrating TPACK and TAM, this study provides a comprehensive framework for understanding teachers' technology integration practices in higher education.

Review of Literature

Technology integration has become a major focus of contemporary educational research. Numerous studies have examined how digital technologies influence teaching

practices and learning outcomes in higher education. Recent research indicates that teachers generally demonstrate positive attitudes toward technology integration and recognise its potential to enhance instructional effectiveness and student engagement. As technology integration has become a focus of investigation in contemporary education, there are a large number of studies. Many of them examined how digital technology influences teaching practices and learning outcomes. The large number of empirical studies show a positive attitude towards technology integration and acknowledge its potential.

Akram et al. (2022) conducted a systematic review of technology integration in education and found that digital technologies can significantly improve teaching practices by facilitating interactive and student-centred learning environments. Similarly, Haleem et al. (2022) highlighted that emerging digital technologies such as virtual learning environments and online collaborative platforms provide opportunities for flexible and accessible learning.

However, despite the potential benefits of digital technologies, there are several barriers that continue to hinder effective technology integration. Bećirović (2023) identified challenges such as inadequate technological infrastructure, limited professional development opportunities, and insufficient institutional support as major obstacles that teachers face when integrating technology into teaching practices. Many studies shows the importance of teachers' technological competencies in facilitating successful technology integration. Teachers who possess strong technological and pedagogical skills are more likely to

adopt innovative teaching strategies using digital tools. Teachers' confidence in using digital technologies plays a crucial role in determining their willingness to experiment with new instructional approaches.

In addition, institutional factors significantly influence teachers' technology integration practices. Access to digital resources, administrative support, and professional training opportunities can enhance teachers' ability to integrate technology into teaching. Therefore, understanding teachers' perspectives on technology integration is essential for developing effective institutional policies and professional development initiatives that promote sustainable technology integration in higher education.

Research Questions

1. What are the current trends in the usage of innovative technology among higher education teachers in Kerala?
2. Is there a significant difference in technology usage among teachers based on gender?
3. Does teaching experience influence teachers' technology integration practices?
4. What support and resources do teachers require for effective technology integration in higher education?

Statement of the Problem

Several studies indicate that recent years have accelerated the adoption of digital technologies in teaching and learning environments. Teachers were compelled to shift to online and technology-supported teaching methods during the pandemic. Although technology adoption increased during this period, the sustainability of technology integration in the post-pandemic

educational environment remains uncertain.

Despite the growing use of digital technologies in education, teachers and students continue to face several challenges while integrating technology into teaching and learning processes. Therefore, the present study investigates innovative technology integration in teaching among higher education teachers in Kerala.

Hypotheses

1. H1: There will be a significant difference in the usage of innovative technology among teachers based on gender.
2. H2: There will be a significant difference in the usage of innovative technology among teachers based on experience in teaching.

Objectives of the Study

1. To identify the current trends in innovative technology usage among higher education teachers of Kerala.
2. To examine innovative technology usage among higher education teachers of Kerala with respect to gender.
3. To examine innovative technology usage among higher education teachers of Kerala with respect to years of experience.
4. To identify teachers' requirements or needs regarding technology integration.

Objectives 1 and 4 are descriptive in nature and are addressed through descriptive statistics rather than inferential testing. Objectives 2 and 3 correspond to the study's two formal hypotheses (H1 and H2, concerning gender and teaching experience respectively) and are addressed through independent-samples t-tests and one-way ANOVA.

Methodology

Research Design

A quantitative survey research design was adopted to examine teachers' perceptions and practices related to innovative technology integration in higher education. The state of teachers' usage, perspectives, and requirements regarding technology integration are examined using a questionnaire comprising 44 items. It is organised into four sub-parts as current trends, usage, perspective, and teachers' requirements. The questionnaire is prepared by the investigator, validated by subject experts, and distributed via Google Form. The reliability of the instrument is tested using Cronbach's alpha, which yielded a value of 0.87. it indicates high internal consistency.

Population and Sample

The target population comprised faculty members working under the 16 public universities of Kerala. The estimated

population is 32,946 faculty members (All Kerala Higher Education Survey Report, 2020). The required sample size was determined using a sample size calculator based on Cochran's sample size formula with finite population correction (FPC). A simple random sampling technique was employed to select the participants from the target population. Data were collected using a structured questionnaire administered through Google Forms. 356 complete and usable responses were obtained for the final analysis.

Data Analysis

The analysis included Descriptive statistics, independent-samples t-tests, and one-way analysis of variance (ANOVA) with Tukey HSD post hoc comparisons. Data were analysed using SPSS statistical software.

A. Current Trends in Innovative Technology Usage

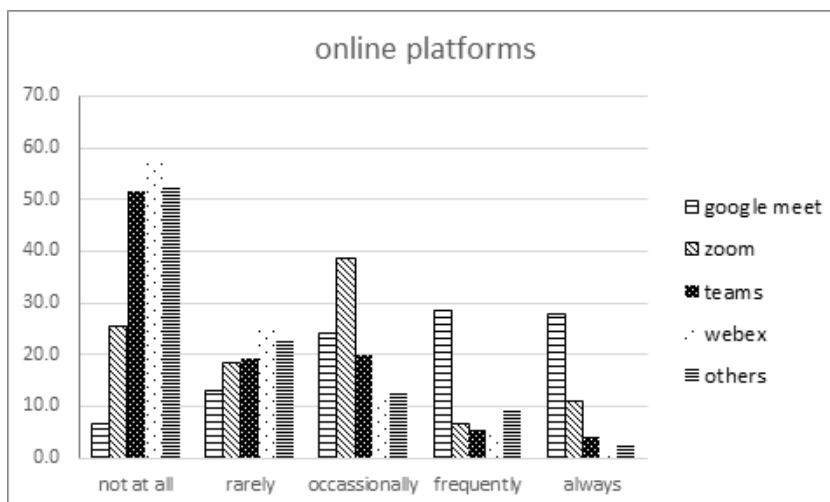


Fig. 1. Usage of online platforms

Fig. 1 shows the percentage of teachers using various online platforms for teaching: 27.8% of teachers use Google Meet always and 28.7% use it frequently, with Zoom the

next most popular platform; only a small percentage of teachers prefer Teams and Webex.

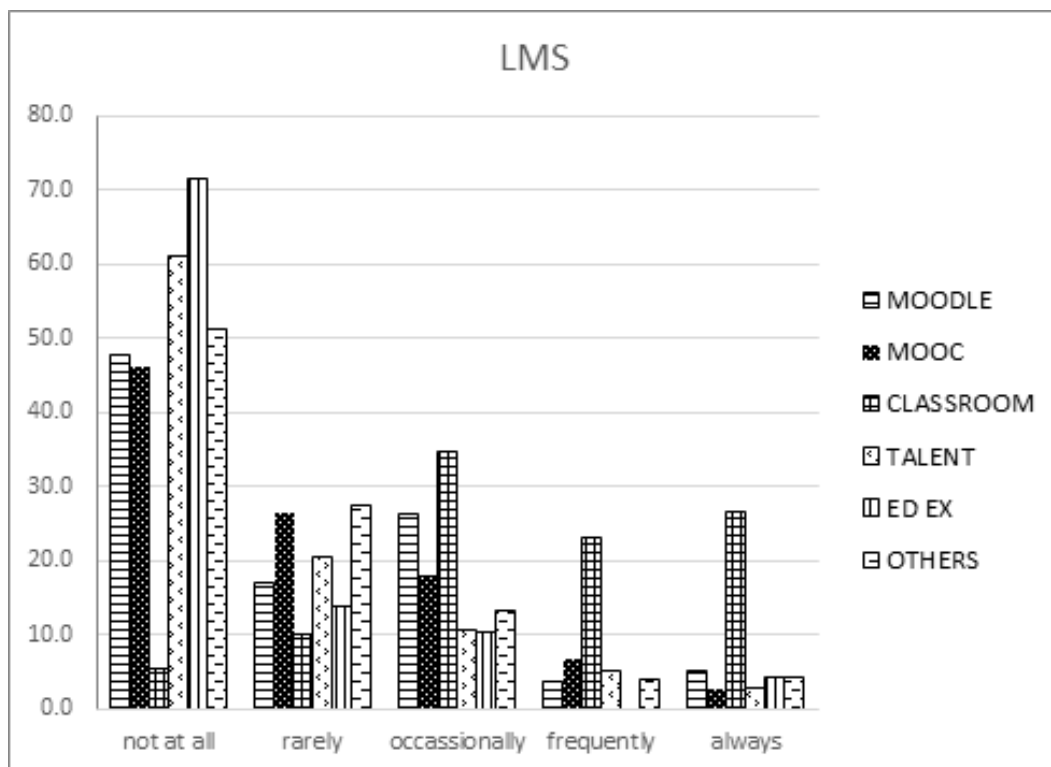


Fig. 2. Usage of learning management systems

Fig. 2 shows the percentage of teachers using various learning management systems: 26.7% of teachers use Google Classroom always, 23% use it frequently,

and 34.8% use it occasionally; only a small percentage of teachers prefer other LMS platforms.

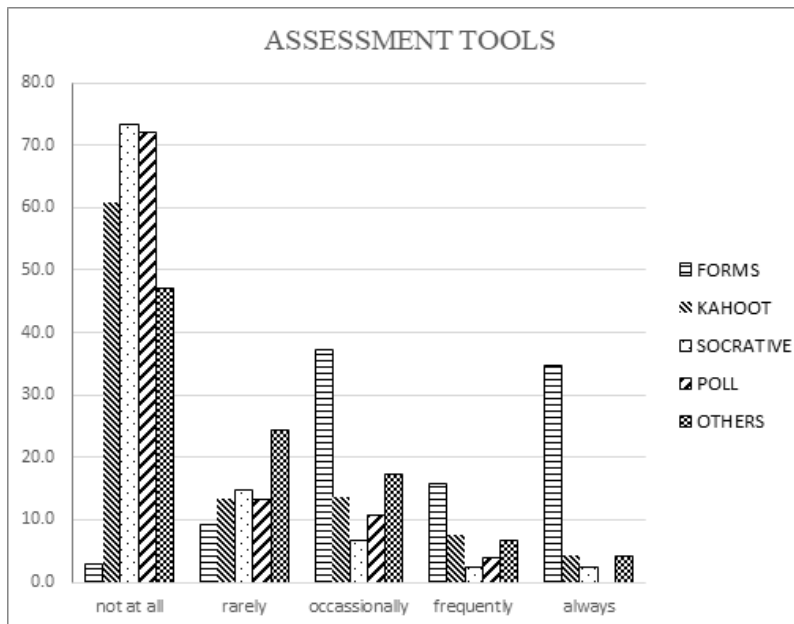


Fig. 3. Usage of assessment tools

Fig. 3 shows that Google Forms is the most widely used assessment tool: 34.8% of teachers use it always, 15.7% use it frequently, and 37.4% use it occasionally.

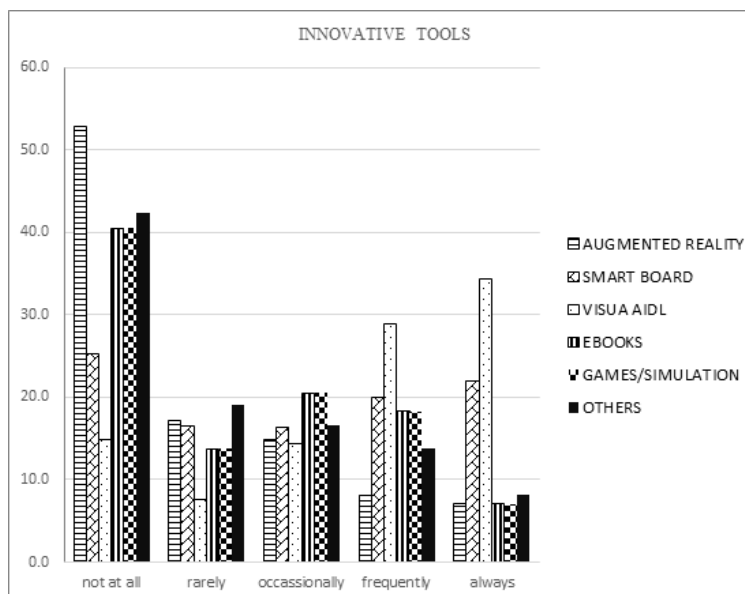


Fig. 4. Usage of innovative tools

Fig. 4 shows that half of the teachers do not use innovative tools such as augmented reality or e-books; the most-used innovative

tool is visual aids, with 34.3% of teachers using it always and 28.9% using it frequently.

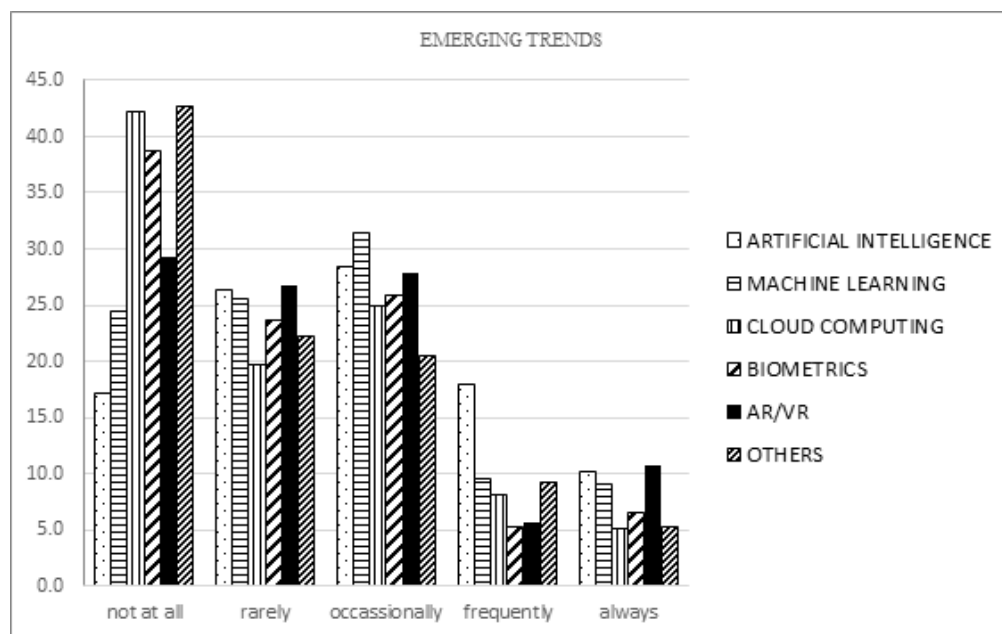


Fig. 5. Usage of emerging trends in education

Fig. 5 shows that the use of emerging technological tools in teaching remains very low.

B. Technology Usage by Gender

Table 1

Independent-Samples *t*-Test of Innovative Technology Usage by Gender

Gender	N	Mean	SD	df	t	p
Female	308	64.89	18.598	354	0.346	.729
Male	48	63.90	18.331			

Note. $d = 0.05$ (negligible effect, Cohen, 1988).

An independent-samples *t*-test showed no statistically significant difference in the usage of innovative technology between male and female higher education teachers in Kerala, $t(354) = 0.35$, $p = .729$, $d = 0.05$. Hypothesis 1 (H1) was therefore not supported for the usage dimension.

C. Technology Usage by Years of Experience

Table 2

One-Way ANOVA of Innovative Technology Usage by Teaching Experience

Source	SS	df	MS	F	p
Between Groups	2609.368	2	1304.684	3.857	.022
Within Groups	119407.857	353	338.266		
Total	122017.225	355			

Note. $\eta^2 = .021$ (small effect).

A one-way ANOVA indicated a statistically significant difference in the usage of innovative technology among teachers with different levels of teaching experience, $F(2, 353) = 3.86$, $p = .022$, $\eta^2 = .021$. A Tukey HSD post hoc test was conducted to identify which groups differed.

Table 3

Tukey HSD Multiple Comparisons of Usage by Years of Experience

(I) Experience	(J) Experience	Mean Diff. (I-J)	SE	p	95% CI
0-5	5-10	-2.619	2.429	.528	[-8.336, 3.098]
0-5	10+	4.431	2.293	.131	[-.966, 9.828]
5-10	10+	7.050*	2.606	.020	[.916, 13.184]

Note. *The mean difference is significant at the 0.05 level.

There was no statistically significant difference in usage of innovative technology between teachers with 0-5 years' and 5-10 years' experience, nor between teachers with 0-5 years' and 10+ years' experience. However, there was a statistically significant difference between teachers with 5-10 years' and 10+ years' experience.

D. Teachers' Perspective by Gender

Table 4

Independent-Samples t-Test of Teachers' Perspective by Gender

Gender	N	Mean	SD	df	t	p
Female	308	41.39	7.39	354	0.612	.541
Male	48	40.68	7.90			

Note. $d = 0.10$ (negligible effect).

The obtained t-value for teachers' perspective with regard to gender, $t(354) = 0.61$, $p = .541$, $d = 0.10$, was not significant at the 0.05 level. There is therefore no significant difference between male and female teachers with regard to perspective towards technology integration in teaching, and Hypothesis 1 (H1) is not supported for the perspective dimension either.

E. Teachers' Perspective by Years of Experience

Table 5

One-Way ANOVA of Teachers' Perspective by Teaching Experience

Source	SS	df	MS	F	p
Between Groups	739.235	2	369.617	6.86	.001
Within Groups	19015.605	353	53.869		
Total	19754.840	355			

Note. $\eta^2 = .037$ (small effect).

The ANOVA result for teachers' perspective towards technological integration was statistically significant, $F(2, 353) = 6.86$, $p = .001$, $\eta^2 = .037$, indicating a significant difference in teachers' perspective with respect to years of teaching experience. A Tukey HSD post hoc test was conducted to identify which groups differed.

Table 6

Tukey HSD Multiple Comparisons of Perspective by Years of Experience

(I) Experience	(J) Experience	Mean Diff. (I-J)	SE	p	95% CI
0-5	5-10	-3.608*	.969	.005	[-5.342, -.779]
0-5	10+	-2.763*	.915	.008	[-4.916, -.609]
5-10	10+	.298	1.040	.956	[-2.150, 2.746]

Note. *The mean difference is significant at the 0.05 level.

There was no statistically significant difference in teachers' perspective towards technology integration between teachers with 5-10 years' and 10+ years' experience. However, there was a statistically significant difference between teachers with 0-5 years' and 5-10 years' experience, and between teachers with 0-5 years' and 10+ years' experience. Thus, Hypothesis 2 (H2) is supported for the perspective dimension.

F. Teachers' Requirements and Needs

Table 7

Teachers' Requirements and Needs Regarding Technology Integration (%)

Response	A	B	C	D	E
Strongly Disagree	3.9	0.0	3.9	0.0	1.4
Disagree	3.9	6.7	5.6	8.1	2.5
Neutral	13.2	12.1	7.9	9.3	12.9
Agree	49.7	52.2	45.8	52.5	52.5
Strongly Agree	29.2	28.9	36.8	30.1	30.6
Total	100.0	100.0	100.0	100.0	100.0

Note. A = more access to innovative technology; B = more opportunities to collaborate with field experts; C = more technical training for professional development; D = more time to integrate emerging technology; E = more support from administration for technological integration in education.

On average, 50.02% of teachers agreed and 31.2% strongly agreed that they require greater access, collaboration opportunities, technical training, time, and administrative support for technology integration.

Overall, the results indicate that teaching experience significantly influences technology usage and perspective among higher education teachers, while gender does not significantly affect either dimension.

Discussion of Results

The findings of the study shows important insights of current status of technology integration in higher education in kerala. The result shows that teachers widely use various technology in education in their teaching practice consistent with Akram et al.'s (2022) systematic review finding that digital technologies are now embedded in everyday instructional routines. This suggests that digital communication technologies continue to play a significant role in contemporary higher education.

The findings shows that the educators are familiar with the most used technologies but the emerging technologies like augmented reality, artificial intelligence are relatively limited. This pattern echoes Bećirović's (2023) observation that inadequate infrastructure and limited professional-development opportunities constrain teachers from moving beyond basic digital tools toward more advanced ones. It can be related to kerala aspect also.

The study also found that teaching experience significantly influences technology usage and teachers' perspectives toward technology integration. But the gender is not significant. This finding,

consistent with the framing offered by Howard et al. (2021) on teachers' readiness profiles, suggests that professional-development programmes tailored to career stage rather than to gender may play the more important role in improving teachers' technological competencies.

Another significant finding is, teachers require greater institutional support which includes access to technological resources, professional training opportunities, and administrative encouragement. These findings, taken together with the barriers identified by Becirovic (2023), highlight the importance of institutional strategies that support teachers in integrating technology into teaching practices.

Overall, the results suggest that although teachers recognise the pedagogical benefits of digital technologies, institutional barriers continue to limit their effective implementation. Addressing these challenges requires coordinated efforts from educational institutions, policymakers, and teacher training programmes, informed jointly by TAM's emphasis on ease of use and TPACK's emphasis on integrated teacher knowledge.

Limitations

The study relied on self-report survey data collected through a single, cross-sectional Google Form administration, which may be subject to social-desirability and common-method bias and cannot establish causal relationships between the variables studied.

The sample was drawn exclusively from public universities in Kerala; findings may not generalise to private institutions, other Indian states, or international higher-education contexts.

The gender distribution of the sample (308 female, 48 male) was imbalanced relative to the general faculty population, which may limit the precision of gender-based comparisons despite the statistical tests employed.

Online distribution via Google Form may have under-represented teachers with limited digital access or lower digital confidence a group of particular relevance to a study of technology integration.

The study did not incorporate qualitative data (e.g., interviews or classroom observation) that could have triangulated and enriched the survey findings.

Conclusion

The present study examined teachers' perspectives on innovative technology integration in higher education institutions in Kerala. The results of the study strongly indicate that teachers generally possess positive attitude towards technology integration and frequently uses them. But still they face barriers to adopt the emerging technologies due to insufficient support and training. The problem should be properly addressed and rectified. The study highlights the importance to provide continuous professional development opportunities for teachers to enhance their technological competencies. Educational institutions should also invest in technological infrastructure. They should develop supportive policies that encourage teachers to integrate innovative technologies into teaching. Future research could explore technology integration practices in different educational contexts. And also need to examine how institutional policies influence teachers' technology adoption behaviours, ideally using longitudinal or mixed-methods designs that address the limitations noted above.

Suggestions

As per the empirical results of the study and the needed showed in Table 7, the following suggestions are listed for institutions, policymakers, and teacher-training programmes:

For institutions: Provide consistent sufficient time for technical training and professional development. Results shows that 82.6% of respondents agreed or strongly agreed that they need more time to integrate emerging technology (Table 7). Longitudinal sessions should be conducted that helps teachers progress from basic digital literacy to integrating technology within their specific subject pedagogy, consistent with the TPACK principle that technological, pedagogical, and content knowledge must be developed together rather than as separate skills.

For policymakers: prioritize infrastructure investment and administrative support mechanisms, since 83.1% of teachers agreed or strongly agreed that they need more administrative support for technological integration (Table 7, column E).

For teacher-training programs: design experience-stage-specific interventions rather than one-size-fits-all training, since the study's findings show that the sharpest differences in both usage and perspective occur between mid-career (5–10 years) and senior (10+ years) teachers rather than by gender.

For institutions: establish structured peer-mentoring or peer-support arrangements pairing teachers who have successfully integrated emerging tools with those who have not, addressing the 81.1% agreement/strong-agreement for

more opportunities to collaborate with field experts (Table 7, column B).

Conflicts of Interest

The authors declare that they have no known conflicts of interest associated with this research. No funding was received from any organisation that could be perceived as having a direct or indirect influence on the study design, data analysis, or interpretation of results.

Consent to Participate

The study involved voluntary participation from higher education teachers. Prior to participation, respondents were informed about the purpose of the study, and their participation was entirely voluntary. Informed consent was obtained from all participants.

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