

UNDERSTANDING COGNITIVE INDEPENDENCE AMONG CULTURALLY DIVERSE LEARNERS: EVIDENCE FROM AN INNOVATIVE ASSESSMENT FRAMEWORK

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Abstract

Cognitive independence is increasingly recognized as a crucial educational outcome that enables learners to think critically, make informed decisions, solve problems autonomously, and adapt to complex learning environments. In culturally diverse educational settings, understanding variations in cognitive independence becomes essential for promoting inclusive and equitable learning opportunities. This study investigates cognitive independence among learners from diverse cultural, linguistic, and socioeconomic backgrounds through the implementation of an innovative assessment framework specifically designed to evaluate autonomous thinking, self-regulated learning, decision-making ability, reflective judgment, and problem-solving competence. The framework integrates quantitative assessment measures with qualitative observations to provide a comprehensive understanding of learner autonomy across different educational contexts. The study was conducted among undergraduate students representing varied demographic groups. Data were collected using a Cognitive Independence Assessment Device and analyzed through descriptive and inferential statistical techniques. The findings reveal significant improvements in learners' ability to engage in independent reasoning, critical evaluation, and self-directed learning activities. The results further indicate that culturally responsive assessment practices help reduce biases often associated with conventional evaluation methods and provide a more accurate representation of learners' cognitive capabilities. The study highlights the importance of innovative assessment frameworks in fostering educational equity, supporting diverse learners, and promoting lifelong learning skills. The findings offer valuable implications for educators, curriculum developers, and policymakers seeking to strengthen inclusive educational practices and learner autonomy in multicultural learning environments.

1.INTRODUCTION

The twenty-first century and socioeconomic diversity. educational landscape is characterized by Globalization, international migration, unprecedented cultural, linguistic, ethnic, technological advancement, and expanding

access to higher education have transformed classrooms into multicultural learning environments where students bring varied experiences, perspectives, and cognitive orientations. While diversity enriches educational experiences and promotes intercultural understanding, it also presents challenges for educators seeking to provide equitable learning opportunities for all students. One of the most significant educational goals in such contexts is the development of cognitive independence, a critical capability that enables learners to think autonomously, make informed decisions, evaluate information critically, and solve problems without excessive external guidance.

Cognitive independence refers to an individual's ability to engage in self-directed thinking, exercise personal judgment, regulate learning processes, and construct knowledge through independent reasoning. It extends beyond academic achievement and encompasses the development of intellectual autonomy, reflective thinking, metacognitive awareness, and self-regulated learning. In contemporary educational settings, cognitive independence has emerged as a foundational skill necessary for lifelong learning, innovation, adaptability, and active participation in democratic societies.

As knowledge economies increasingly demand individuals who can analyze complex information, generate creative solutions, and make independent decisions, fostering cognitive independence has become a central objective of educational systems worldwide.

The concept of cognitive independence is rooted in several influential educational and psychological theories. Constructivist theorists argue that learners actively construct knowledge through interaction with their environments rather than passively receiving information from teachers. According to this perspective, meaningful learning occurs when individuals engage in inquiry, reflection, and problem-solving activities that require independent thinking. Similarly, social constructivist approaches emphasize the role of cultural and social contexts in shaping cognitive development while recognizing learners as active participants in knowledge construction. These theoretical perspectives highlight the importance of creating educational environments that encourage autonomy, exploration, and critical engagement with knowledge.

Cognitive independence is closely associated with self-regulated learning,

which involves learners' ability to plan, monitor, evaluate, and adjust their learning strategies. Self-regulated learners demonstrate greater academic resilience, motivation, and achievement because they take responsibility for their own learning processes. Research has consistently shown that students who possess strong self-regulatory skills are better equipped to navigate academic challenges, manage learning tasks, and achieve educational goals. Consequently, understanding and measuring cognitive independence has become increasingly important for educators seeking to support diverse learners effectively.

The significance of cognitive independence becomes particularly evident in culturally diverse educational settings. Students from different cultural backgrounds often possess distinct learning styles, communication patterns, problem-solving approaches, and epistemological beliefs. Cultural values influence how learners perceive authority, approach knowledge acquisition, engage in collaborative activities, and demonstrate intellectual autonomy. For example, students from collectivist cultures may emphasize cooperation and social harmony, whereas those from individualistic cultures may prioritize personal initiative and independent decision-making. Such

differences can affect how cognitive independence is expressed and assessed within educational environments.

Traditional assessment methods have often been criticized for failing to account adequately for cultural diversity. Standardized tests and conventional evaluation practices frequently emphasize uniform performance criteria that may privilege certain cultural norms while disadvantaging others. Consequently, learners from diverse backgrounds may not receive fair opportunities to demonstrate their true cognitive capabilities. Educational researchers have increasingly argued that culturally responsive assessment approaches are necessary to ensure equity and inclusivity in educational evaluation. Such approaches recognize the diverse ways in which learners process information, solve problems, and demonstrate understanding.

The growing emphasis on educational equity has further intensified interest in understanding cognitive independence among culturally diverse learners. Educational equity involves ensuring that all students, regardless of cultural, linguistic, socioeconomic, or demographic differences, have access to meaningful learning opportunities and fair

assessment practices. Achieving educational equity requires a comprehensive understanding of how diverse learners develop cognitive skills and how assessment systems can accurately capture their intellectual growth. Consequently, researchers and educators have begun exploring innovative assessment frameworks capable of evaluating cognitive independence in ways that are culturally sensitive, inclusive, and contextually relevant.

Recent advances in educational technology have created new opportunities for assessing cognitive independence. Digital assessment tools, learning analytics, adaptive learning systems, and artificial intelligence-based evaluation platforms enable educators to collect comprehensive data regarding learners' cognitive processes, decision-making patterns, and self-regulated learning behaviors. Unlike traditional assessments that primarily measure content knowledge, innovative assessment frameworks can provide insights into how learners think, reason, reflect, and solve problems. Such frameworks offer the potential to evaluate cognitive independence more accurately while minimizing cultural biases that may affect conventional assessment methods.

Innovative assessment frameworks are particularly valuable because they focus on process-oriented evaluation rather than solely outcome-based measurement. Process-oriented assessments examine learners' approaches to problem-solving, decision-making, reflection, and strategy selection. These assessments recognize that learning is a dynamic and multifaceted process influenced by cognitive, social, emotional, and cultural factors. By examining learners' cognitive processes, educators can gain deeper insights into their strengths, challenges, and developmental needs. This information can subsequently inform instructional interventions designed to promote greater cognitive independence and academic success.

The development of cognitive independence is increasingly recognized as a key component of twenty-first-century competencies. International educational organizations emphasize critical thinking, creativity, problem-solving, collaboration, communication, and self-directed learning as essential skills for future success. Cognitive independence serves as a foundational element underlying many of these competencies because it enables individuals to apply knowledge flexibly, evaluate information critically, and adapt to changing circumstances. Educational

institutions are therefore under growing pressure to design curricula, teaching methodologies, and assessment systems that foster autonomous thinking and lifelong learning capabilities.

In multicultural classrooms, fostering cognitive independence requires educators to acknowledge and respect diverse cultural perspectives while encouraging intellectual exploration and self-directed inquiry. Culturally responsive pedagogy plays an important role in this process by incorporating learners' cultural experiences, values, and identities into instructional practices. Such approaches help create inclusive learning environments where students feel valued, respected, and empowered to contribute their unique perspectives. When learners perceive their cultural identities as assets rather than obstacles, they are more likely to engage actively in learning and develop confidence in their cognitive abilities.

Despite growing recognition of the importance of cognitive independence, significant gaps remain in the literature regarding its assessment among culturally diverse learner populations. Many existing assessment instruments were developed within specific cultural contexts and may not adequately capture variations in

cognitive behavior across diverse groups. Furthermore, limited research has explored how innovative assessment frameworks can be utilized to evaluate cognitive independence in inclusive educational settings. Addressing these gaps is essential for advancing educational equity and improving understanding of learner autonomy in multicultural environments.

The present study seeks to contribute to this emerging field by examining cognitive independence among culturally diverse learners through the application of an innovative assessment framework. The framework was specifically designed to evaluate multiple dimensions of cognitive independence, including autonomous reasoning, reflective thinking, decision-making ability, problem-solving competence, metacognitive awareness, and self-regulated learning. By employing a comprehensive and culturally responsive assessment approach, the study aims to provide a more nuanced understanding of how cognitive independence manifests across diverse learner populations.

The innovative assessment framework integrates quantitative and qualitative measures to capture the complexity of cognitive independence.

Quantitative indicators provide objective evidence of learner performance, while qualitative observations offer insights into learners' cognitive processes, strategies, and experiences. This mixed-methods approach enhances the validity and reliability of assessment outcomes by recognizing that cognitive independence cannot be fully understood through numerical scores alone. Instead, it requires a holistic examination of learners' behaviors, reflections, and decision-making patterns within authentic learning contexts.

Another important aspect of the study is its focus on inclusivity and cultural responsiveness. The assessment framework was developed with consideration for diverse cultural perspectives and learning preferences. By reducing cultural bias and emphasizing authentic performance tasks, the framework seeks to provide equitable opportunities for all learners to demonstrate their cognitive capabilities. Such an approach aligns with contemporary educational goals emphasizing fairness, diversity, and inclusion.

The findings of this study have important implications for educational practice, policy development, and future research. Understanding how cognitive independence develops among culturally diverse learners can inform the design of

instructional strategies, assessment systems, and support services that promote learner autonomy and academic success. Educational policymakers may also benefit from insights regarding the development of equitable assessment practices capable of addressing the needs of increasingly diverse student populations.

In conclusion, cognitive independence represents a vital educational outcome in contemporary multicultural societies. As classrooms become more diverse and educational expectations continue to evolve, understanding how learners develop and demonstrate cognitive independence has become increasingly important. Traditional assessment methods alone may be insufficient to capture the complexity of autonomous thinking and self-directed learning among culturally diverse students. Innovative assessment frameworks offer promising alternatives capable of providing more comprehensive, equitable, and culturally responsive evaluations. By investigating cognitive independence through such a framework, the present study seeks to contribute valuable knowledge to the fields of diversity studies, educational assessment, and learner development while supporting broader efforts to create inclusive and

empowering educational environments for all learners.

2. OBJECTIVES OF THE STUDY

1. To assess the level of cognitive independence among culturally diverse learners using an innovative assessment framework.
2. To examine the relationship between cultural diversity and cognitive independence in educational settings.
3. To evaluate the effectiveness of the innovative assessment framework in measuring autonomous thinking and self-regulated learning.
4. To identify variations in problem-solving, decision-making, and reflective thinking skills among learners from different cultural backgrounds.
5. To explore the implications of cognitive independence assessment for promoting inclusive and equitable educational practices.

3. REVIEW OF LITERATURE

The concept of cognitive independence has gained substantial attention in contemporary educational research due to its close association with

critical thinking, self-regulated learning, problem-solving ability, and learner autonomy. As educational institutions increasingly emphasize inclusive and equitable learning environments, researchers have explored how cognitive independence develops among learners from diverse cultural, linguistic, and socioeconomic backgrounds. Recent studies highlight the importance of innovative assessment frameworks capable of measuring higher-order cognitive abilities while addressing the complexities associated with diversity in educational settings. This review examines recent scholarly contributions related to cognitive independence, culturally responsive assessment, self-regulated learning, learner autonomy, educational equity, and innovative assessment technologies.

One of the most significant developments in educational research during the past decade has been the growing recognition of learner autonomy as a central objective of education. According to Zimmerman (2020), autonomous learners demonstrate higher levels of self-efficacy, motivation, and academic achievement because they actively regulate their cognitive processes and learning strategies. Self-regulated learning enables students to set goals, monitor progress, evaluate

outcomes, and adapt learning approaches based on contextual demands. Zimmerman argues that cognitive independence serves as the foundation of self-regulated learning because independent thinkers are more capable of making informed decisions regarding their educational activities.

Similarly, Panadero (2021) emphasizes that self-regulation and cognitive independence are interconnected constructs that contribute significantly to academic success. His research indicates that learners who engage in reflective thinking and metacognitive monitoring develop stronger problem-solving abilities and greater intellectual autonomy. Panadero further notes that educational systems must move beyond rote learning practices and create opportunities for students to participate actively in knowledge construction. Such participation encourages learners to assume responsibility for their own intellectual development and strengthens cognitive independence.

Recent investigations into critical thinking have also contributed to understanding cognitive independence. Facione (2020) identifies critical thinking as a multidimensional process involving interpretation, analysis, evaluation, inference, explanation, and self-regulation.

According to his findings, learners who possess strong critical thinking skills demonstrate greater independence in evaluating information and making reasoned judgments. Educational interventions designed to promote critical thinking have been shown to enhance learners' cognitive flexibility and decision-making capabilities, thereby contributing to the development of cognitive independence.

The relationship between cognitive independence and problem-solving competence has received considerable scholarly attention. Research conducted by Hmelo-Silver and Chinn (2022) suggests that inquiry-based learning environments significantly enhance learners' ability to solve complex problems independently. Their study demonstrates that students exposed to problem-centered instructional strategies exhibit higher levels of autonomous reasoning, analytical thinking, and reflective judgment. These findings support the view that cognitive independence develops most effectively when learners engage in authentic problem-solving experiences rather than passive information acquisition.

The influence of cultural diversity on cognitive development has emerged as

an important area of educational research. Gay (2021) argues that culture shapes learners' cognitive styles, communication patterns, learning preferences, and approaches to knowledge construction. Consequently, educational practices that fail to acknowledge cultural diversity may limit learners' opportunities to demonstrate their intellectual capabilities. Gay emphasizes the importance of culturally responsive pedagogy, which incorporates students' cultural experiences into teaching and assessment practices. Such approaches create inclusive learning environments that support the development of cognitive independence among diverse learner populations.

Ladson-Billings (2021) further highlights the significance of culturally relevant education in promoting academic achievement and intellectual empowerment. Her research indicates that students perform more effectively when instructional practices recognize and value their cultural identities. Culturally relevant pedagogy encourages learners to connect academic content with real-world experiences, thereby fostering deeper engagement and independent thinking. The study suggests that educational equity can be achieved only when diversity is viewed

as a resource rather than a barrier to learning.

Recent studies have also examined the relationship between multicultural education and learner autonomy. Banks (2022) argues that multicultural educational environments provide opportunities for learners to encounter diverse perspectives, challenge assumptions, and develop critical consciousness. Exposure to multiple viewpoints encourages learners to engage in reflective thinking and independent judgment, both of which are essential components of cognitive independence. Banks emphasizes that multicultural education contributes not only to social inclusion but also to cognitive growth and intellectual development.

The growing emphasis on educational equity has intensified interest in fair and inclusive assessment practices. Traditional assessment methods have often been criticized for reinforcing cultural biases and privileging dominant cultural norms. According to Brookhart (2021), standardized assessments frequently fail to capture the diverse ways in which learners demonstrate understanding and cognitive competence. Such assessments may underestimate the abilities of students from culturally and linguistically diverse

backgrounds because they rely heavily on uniform evaluation criteria.

In response to these concerns, educational researchers have advocated for culturally responsive assessment frameworks. Solano-Flores (2021) argues that assessment validity depends on the extent to which evaluation methods accurately represent learners' knowledge and abilities across different cultural contexts. His research highlights the need for assessment instruments that consider linguistic diversity, cultural experiences, and contextual factors influencing learner performance. Culturally responsive assessments aim to reduce bias and provide more equitable opportunities for students to demonstrate cognitive independence.

Recent advancements in performance-based assessment have contributed significantly to the evaluation of higher-order cognitive skills. Darling-Hammond and Hyler (2022) emphasize that authentic assessments provide a more comprehensive understanding of learner capabilities than traditional examinations. Performance-based tasks require students to apply knowledge, analyze information, solve problems, and justify decisions in realistic contexts. These activities enable educators to assess cognitive independence

more effectively because they focus on learners' reasoning processes rather than merely measuring factual recall.

The integration of technology into educational assessment has created new possibilities for evaluating cognitive independence. Digital assessment systems allow educators to collect detailed information regarding learners' cognitive behaviors, learning strategies, and decision-making processes. According to Ifenthaler and Yau (2022), learning analytics technologies provide valuable insights into how students interact with learning materials, monitor progress, and regulate their learning activities. Such technologies facilitate continuous assessment and support the identification of patterns associated with cognitive independence.

Artificial intelligence has emerged as another significant innovation in educational assessment. Holmes, Bialik, and Fadel (2021) argue that AI-powered assessment systems can analyze complex learner data and generate personalized feedback that supports cognitive development. These systems are capable of evaluating multiple dimensions of learner performance, including problem-solving processes, critical thinking skills, and metacognitive behaviors. By providing

adaptive and individualized assessment experiences, AI technologies contribute to more accurate evaluations of cognitive independence.

Research on adaptive learning environments further demonstrates the potential of technology-enhanced assessment. Adaptive systems adjust instructional content and assessment tasks based on learners' performance levels and cognitive needs. Studies conducted by Khosravi et al. (2023) reveal that adaptive assessment frameworks improve learner engagement, motivation, and self-regulated learning. The findings suggest that personalized learning experiences encourage students to take greater responsibility for their learning processes and develop stronger cognitive independence.

Metacognition has been identified as another critical factor influencing cognitive independence. Schraw and Dennison (2020) define metacognition as individuals' awareness and regulation of their own thinking processes. Learners with strong metacognitive skills are better able to plan, monitor, and evaluate their learning activities. Recent studies indicate that metacognitive instruction enhances academic achievement, critical thinking,

and self-directed learning. These findings support the argument that cognitive independence is closely linked to learners' ability to reflect upon and regulate their cognitive activities.

Research concerning reflective thinking also provides valuable insights into cognitive independence. Mezirow's transformative learning framework continues to influence contemporary studies examining how learners critically evaluate assumptions and construct new understandings. Recent investigations by Cranton and Taylor (2021) demonstrate that reflective learning activities promote intellectual autonomy by encouraging learners to question existing beliefs and consider alternative perspectives. Reflection enables individuals to engage in deeper cognitive processing, thereby strengthening independent reasoning and judgment.

Several recent studies have explored cognitive independence within higher education contexts. Van Alten et al. (2022) found that active learning strategies such as collaborative problem-solving, inquiry-based instruction, and project-based learning significantly enhance students' independent thinking skills. Learners participating in active learning

environments demonstrated greater confidence in decision-making and stronger abilities to manage learning tasks independently. The study highlights the importance of learner-centered instructional approaches in promoting cognitive autonomy.

Research focusing specifically on culturally diverse learners reveals important variations in the expression of cognitive independence. Noguera (2021) argues that educational institutions must recognize the influence of social and cultural experiences on cognitive development. Learners from marginalized communities often encounter structural barriers that affect educational participation and intellectual growth. Consequently, equitable assessment frameworks must account for contextual factors influencing learner performance.

Recent investigations into educational inclusion further emphasize the importance of equitable assessment practices. Florian and Black-Hawkins (2022) suggest that inclusive education requires assessment systems capable of recognizing diverse forms of learner competence. Their research advocates for flexible evaluation approaches that accommodate differences in language,

culture, learning style, and cognitive expression. Such approaches are essential for accurately assessing cognitive independence among diverse learner populations.

Studies examining global educational trends indicate increasing recognition of twenty-first-century competencies. The Organisation for Economic Co-operation and Development (OECD, 2023) identifies critical thinking, creativity, self-regulation, problem-solving, and lifelong learning as essential skills for future success. Cognitive independence serves as a central component underlying these competencies because it enables individuals to adapt effectively to complex and rapidly changing environments. Consequently, educational institutions worldwide are seeking assessment frameworks capable of measuring these advanced cognitive skills.

Recent research on innovative assessment frameworks demonstrates their effectiveness in evaluating complex learning outcomes. Pellegrino (2022) argues that modern assessment systems should integrate cognitive, social, emotional, and contextual dimensions of learning. Such multidimensional frameworks provide more comprehensive insights into learner development than

traditional testing approaches. By examining cognitive processes alongside performance outcomes, innovative assessments offer a richer understanding of cognitive independence.

The literature also highlights the importance of mixed-methods approaches in educational assessment. Creswell and Plano Clark (2021) emphasize that combining quantitative and qualitative data enhances the validity of educational research by capturing multiple dimensions of learner experience. Mixed-methods assessment frameworks enable researchers to examine both measurable performance indicators and subjective cognitive processes, thereby providing a more holistic understanding of cognitive independence.

Overall, recent literature demonstrates a growing consensus regarding the importance of cognitive independence as a fundamental educational objective. Scholars consistently emphasize the roles of self-regulated learning, critical thinking, metacognition, reflective practice, culturally responsive pedagogy, and innovative assessment in fostering learner autonomy. At the same time, researchers acknowledge the limitations of traditional assessment methods and advocate for

inclusive frameworks capable of addressing the needs of culturally diverse learners.

Despite substantial progress, gaps remain in understanding how cognitive independence can be assessed equitably across diverse educational contexts. Existing studies often focus on specific aspects of learner autonomy without integrating multiple dimensions of cognitive development into a unified assessment framework. Furthermore, limited research has examined the effectiveness of innovative assessment technologies in measuring cognitive independence among culturally diverse learner populations. These gaps underscore the need for further investigation.

The present study addresses these concerns by employing an innovative assessment framework designed to evaluate cognitive independence through multiple indicators, including autonomous reasoning, self-regulated learning, reflective thinking, decision-making ability, and problem-solving competence. By focusing on culturally diverse learners, the study contributes to ongoing efforts to develop equitable, inclusive, and contextually relevant assessment practices that support educational diversity and learner empowerment.

4. METHODOLOGY

4.1 Research Design

The present study employed a mixed-methods research design to investigate cognitive independence among culturally diverse learners using an innovative assessment framework. A mixed-methods approach was selected because cognitive independence is a multidimensional construct that encompasses measurable cognitive behaviors as well as subjective experiences, perceptions, and learning strategies. Combining quantitative and qualitative methods enabled a comprehensive examination of learners' autonomous thinking, decision-making, self-regulation, and problem-solving abilities.

The quantitative component focused on measuring cognitive independence through standardized assessment scores generated by the Cognitive Independence Assessment Framework (CIAF), while the qualitative component explored learners' experiences and perceptions through reflective journals, classroom observations, and semi-structured interviews. The integration of both approaches enhanced the validity,

reliability, and comprehensiveness of the findings.

4.2 Research Setting

The study was conducted in selected engineering and arts and science colleges located in Tamil Nadu, India. These institutions were chosen because they represented culturally diverse learning environments consisting of students from various linguistic, ethnic, socioeconomic, and educational backgrounds.

The participating institutions admitted students from rural, semi-urban, and urban regions and reflected the diversity typically found in contemporary higher education settings. Such diversity provided an appropriate context for examining variations in cognitive independence among learners with different cultural experiences.

4.3 Participants

A total of 300 undergraduate students participated in the study. The participants were selected using stratified random sampling to ensure adequate representation of diverse cultural and demographic groups.

The sample consisted of:

Category	Number of Participants	Percentage
Male Students	165	55%

Female Students	135	45%
Rural Background	140	46.7%
Urban Background	160	53.3%
First-Generation Learners	98	32.7%
Continuing-Generation Learners	202	67.3%
Multilingual Learners	174	58%
Monolingual Learners	126	42%

Participants ranged in age from 18 to 22 years and were enrolled in various undergraduate disciplines. Prior to participation, informed consent was obtained from all students.

4.4 Development of the Innovative Assessment Framework

A major objective of the study was to evaluate cognitive independence using a specially designed Innovative Cognitive Independence Assessment Framework (ICIAF).

The framework was developed through the following stages:

Stage 1: Identification of Constructs

Based on extensive literature review and expert consultation, six major dimensions of cognitive independence were identified:

1. Autonomous Reasoning
2. Critical Thinking
3. Self-Regulated Learning

4. Reflective Thinking
5. Independent Decision-Making
6. Problem-Solving Competence

These dimensions collectively represented the broader construct of cognitive independence.

Stage 2: Item Construction

A pool of 75 assessment items was initially developed. The items included:

- Scenario-based questions
- Problem-solving tasks
- Decision-making activities
- Reflective prompts
- Self-regulation inventories
- Critical analysis exercises

The items were designed to minimize cultural bias and allow learners from different backgrounds to demonstrate their cognitive abilities fairly.

Stage 3: Expert Validation

The draft instrument was evaluated by a panel of eight experts specializing in:

- Educational Psychology
- Assessment and Evaluation
- Diversity Studies
- Higher Education
- Cognitive Science

Based on expert feedback, several items were revised, merged, or eliminated. The final instrument contained 60 items distributed across the six dimensions.

Stage 4: Pilot Testing

The instrument was pilot-tested with 50 undergraduate students who were not included in the main study. Reliability analysis produced a Cronbach's Alpha value of 0.89, indicating high internal consistency and reliability.

4.5 Instruments Used for Data Collection

4.5.1 Cognitive Independence Assessment Device (CIAD)

The primary instrument used in the study was the Cognitive Independence Assessment Device developed specifically for this investigation.

The device assessed:

- Independent thinking
- Reasoning ability
- Cognitive flexibility
- Self-monitoring
- Decision-making competence
- Reflective judgment

Scores ranged from 0 to 100. Higher scores indicated greater cognitive independence.

4.5.2 Self-Regulated Learning Scale

To measure learners' ability to manage their own learning processes, a Self-Regulated Learning Scale consisting of 20 items was administered.

The scale assessed:

- Goal setting
- Planning
- Monitoring
- Self-evaluation
- Learning strategy use

Responses were recorded using a five-point Likert scale.

4.5.3 Reflective Learning Journal

Participants maintained weekly reflective journals for six weeks.

The journals encouraged students to describe:

- Learning experiences
- Problem-solving strategies
- Decision-making processes
- Challenges encountered
- Self-evaluation practices

These reflections provided rich qualitative data concerning learners' cognitive independence.

4.5.4 Semi-Structured Interviews

A subgroup of 30 participants was selected for interviews.

The interviews focused on:

- Perceptions of independent learning
- Experiences with diverse learning environments
- Problem-solving approaches
- Self-regulation strategies
- Cognitive decision-making patterns

Each interview lasted approximately 30–40 minutes.

4.5.5 Classroom Observation Schedule

Researchers conducted classroom observations using a structured observation protocol.

Observation indicators included:

- Independent participation
- Initiative-taking behavior
- Questioning ability
- Collaborative problem-solving
- Reflective engagement

Observations were conducted over eight weeks.

4.6 Data Collection Procedure

Data collection was conducted over a period of twelve weeks.

Phase I: Pre-Assessment

Participants completed:

- Demographic Information Form
- Cognitive Independence Assessment Device

- Self-Regulated Learning Scale

These instruments established baseline measurements.

Phase II: Learning Activities

Students participated in instructional activities specifically designed to encourage cognitive independence.

These activities included:

- Case study analysis
- Inquiry-based learning
- Reflective writing
- Collaborative problem-solving
- Independent research projects
- Decision-making simulations

The activities were integrated into regular classroom instruction.

Phase III: Observation and Reflection

During the intervention period:

- Classroom observations were conducted.
- Reflective journals were collected weekly.
- Student engagement and independent learning behaviors were documented.

Phase IV: Post-Assessment

At the conclusion of the intervention:

- Cognitive Independence Assessment Device was re-administered.
- Self-Regulated Learning Scale was re-administered.
- Semi-structured interviews were conducted.

The post-assessment data enabled evaluation of changes in cognitive independence.

4.7 Data Analysis Techniques

Quantitative Data Analysis

Quantitative data were analyzed using the Statistical Package for the Social Sciences (SPSS Version 29).

The following statistical techniques were employed:

Descriptive Statistics

Descriptive measures included:

- Mean
- Standard Deviation
- Frequency
- Percentage

These statistics summarized participants' performance levels.

Paired Sample t-Test

A paired sample t-test was conducted to compare pre-test and post-test scores.

The test determined whether statistically significant improvements occurred following implementation of the assessment framework.

Analysis of Variance (ANOVA)

ANOVA was used to identify differences among:

- Rural and urban learners
- Multilingual and monolingual learners
- First-generation and continuing-generation learners

Correlation Analysis

Pearson correlation coefficients were calculated to examine relationships among:

- Cognitive independence
- Self-regulated learning
- Reflective thinking
- Problem-solving competence

Regression Analysis

Multiple regression analysis was performed to identify predictors of cognitive independence.

Independent variables included:

- Cultural diversity indicators
- Self-regulation scores
- Reflective learning scores
- Academic performance measures

Qualitative Data Analysis

Qualitative data obtained from journals, interviews, and observations were analyzed using thematic analysis.

The procedure involved:

1. Data familiarization
2. Initial coding
3. Theme generation
4. Theme review
5. Theme refinement
6. Interpretation

Several recurring themes emerged, including:

- Growth in independent thinking
- Increased confidence in decision-making
- Enhanced self-regulation
- Greater cognitive flexibility
- Positive attitudes toward diverse perspectives

Reliability

Cronbach's Alpha coefficients were:

Dimension	Reliability Coefficient
Autonomous Reasoning	0.88
Critical Thinking	0.91
Self-Regulated Learning	0.87
Reflective Thinking	0.89
Decision-Making	0.86
Problem-Solving	0.90
Overall Scale	0.89

The results indicated excellent reliability.

Triangulation was employed to improve credibility and trustworthiness.

4.8 Validity and Reliability

Several measures were adopted to ensure methodological rigor.

Content Validity

Expert review ensured content relevance and representativeness. The Content Validity Index (CVI) exceeded 0.85 for all dimensions.

Construct Validity

Factor analysis confirmed the six-dimensional structure of the assessment framework.

4.9 Ethical Considerations

The study adhered to established ethical standards governing educational research.

The following measures were implemented:

- Informed consent was obtained from all participants.
- Participation was voluntary.
- Participants could withdraw at any stage without penalty.
- Confidentiality and anonymity were maintained.
- Data were used exclusively for academic and research purposes.
- No physical, psychological, or academic harm was caused to participants.

Institutional permission was obtained from the participating colleges prior to data collection. The methodology adopted in this study provided a rigorous and comprehensive approach for investigating cognitive independence among culturally diverse learners. Through the integration of quantitative and qualitative methods, the Innovative Cognitive Independence Assessment Framework enabled a multidimensional evaluation of autonomous reasoning, critical thinking, self-regulation, reflective

learning, decision-making, and problem-solving abilities. The use of culturally responsive assessment procedures ensured fairness, inclusivity, and validity while generating meaningful evidence regarding the effectiveness of the innovative framework in measuring cognitive independence across diverse educational contexts.

5. RESEARCH ANALYSIS AND DISCUSSION

5.1 Introduction

The primary objective of this study was to examine cognitive independence among culturally diverse learners using an innovative assessment framework specifically designed to evaluate autonomous reasoning, critical thinking, self-regulated learning, reflective thinking, decision-making ability, and problem-solving competence. The analysis focused on identifying changes in learners' cognitive independence levels following participation in instructional activities and assessment procedures embedded within the Cognitive Independence Assessment Framework (CIAF). The findings provide important insights into how culturally responsive assessment practices can

support learner autonomy and educational equity in diverse learning environments. The results presented in this section are based on quantitative data obtained through pre-test and post-test assessments as well as qualitative data derived from reflective journals, classroom observations, and semi-structured interviews.

Table 1

Pre-Test and Post-Test Cognitive Independence Scores

Assessment	N	Mean Score	Standard Deviation	t-value	p-value
Pre-Test	300	62.41	8.37		
Post-Test	300	81.73	7.12	28.64	0.001*

*Significant at $p < 0.05$

Interpretation

Table 1 reveals a substantial increase in overall cognitive independence scores following the implementation of the innovative assessment framework. The mean score increased from 62.41 in the pre-test to 81.73 in the post-test, indicating an improvement of approximately 19 points. The paired sample t-test produced a statistically significant result ($t = 28.64$, $p < 0.001$), demonstrating that the observed improvement was unlikely to have occurred by chance. These findings suggest that the assessment framework effectively enhanced learners' ability to think independently, evaluate information

5.2 Overall Cognitive Independence Scores

The first stage of analysis examined the overall cognitive independence scores of participants before and after exposure to the innovative assessment framework.

critically, and regulate their learning processes. The results support previous studies emphasizing the positive relationship between learner-centered assessment approaches and the development of autonomous learning behaviors.

5.3 Analysis of Cognitive Independence Dimensions

To gain a deeper understanding of learner development, individual dimensions of cognitive independence were analyzed separately.

Table 2

Dimension-Wise Performance Scores

Dimension	Pre-Test Mean	Post-Test Mean	Improvement
Autonomous Reasoning	61.8	82.6	20.8
Critical Thinking	63.2	83.9	20.7
Self-Regulated Learning	64.5	82.8	18.3
Reflective Thinking	60.9	81.4	20.5
Decision-Making Ability	61.6	80.8	19.2
Problem-Solving Competence	62.4	81.9	19.5

Interpretation

The results indicate improvement across all six dimensions of cognitive independence. Autonomous reasoning demonstrated the highest increase, followed closely by critical thinking and reflective thinking. These findings suggest that the assessment framework successfully encouraged learners to engage in analytical reasoning and reflective evaluation. The substantial growth in self-regulated learning indicates that participants became more capable of planning, monitoring, and evaluating their learning activities. This outcome aligns with theories emphasizing the role of metacognition in fostering cognitive independence. The enhancement of

problem-solving competence and decision-making ability further demonstrates that learners became more confident in addressing complex situations independently. Such skills are increasingly important in contemporary educational and professional contexts where adaptability and critical judgment are highly valued.

5.4 Comparison Based on Cultural Diversity Factors

One of the central aims of the study was to explore whether cognitive independence varied across culturally diverse learner groups.

Table 3

Post-Test Cognitive Independence Scores by Background

Learner Group	Mean Score
Rural Students	79.84

Urban Students	83.39
First-Generation Learners	78.62
Continuing-Generation Learners	83.21
Multilingual Learners	84.15
Monolingual Learners	78.96

Interpretation

The results indicate noticeable differences among learner groups. Urban students achieved slightly higher cognitive independence scores than rural students. Similarly, continuing-generation learners outperformed first-generation learners. These differences may reflect variations in educational resources, academic support systems, and exposure to independent learning opportunities.

Interestingly, multilingual learners demonstrated the highest cognitive independence scores among all groups. This finding supports previous research suggesting that multilingualism enhances cognitive flexibility, metacognitive

awareness, and problem-solving skills. Exposure to multiple linguistic systems may encourage learners to approach problems from diverse perspectives and adapt more effectively to novel situations. Although differences were observed, all groups demonstrated significant improvement relative to their pre-test scores, indicating that the innovative assessment framework was effective across diverse learner populations.

5.5 Relationship Between Self-Regulated Learning and Cognitive Independence

The study also examined the relationship between self-regulated learning and cognitive independence.

Table 4

Correlation Analysis

Variable	Cognitive Independence
Self-Regulated Learning	0.81
Reflective Thinking	0.77
Problem-Solving Ability	0.84
Decision-Making Ability	0.79

Interpretation

Strong positive correlations were observed between cognitive independence and all related variables. Problem-solving ability exhibited the strongest relationship ($r = 0.84$), followed by self-regulated learning ($r = 0.81$).

These findings indicate that learners who effectively manage their learning processes tend to demonstrate greater cognitive independence. Similarly, students who engage in reflective thinking and strategic problem-solving are more likely to exhibit

autonomous reasoning and independent judgment.

The results support contemporary theories of self-regulated learning, which emphasize learners' active participation in planning, monitoring, and evaluating their educational experiences.

5.6 Predictors of Cognitive Independence

Multiple regression analysis was conducted to identify factors influencing cognitive independence.

Table 5

Regression Analysis

Predictor Variable	Beta Value	Significance
Self-Regulated Learning	0.42	0.001
Problem-Solving Competence	0.38	0.001
Reflective Thinking	0.29	0.002
Multilingual Ability	0.21	0.011
Academic Performance	0.18	0.026

Interpretation

Self-regulated learning emerged as the strongest predictor of cognitive independence, followed closely by problem-solving competence. These findings indicate that learners who actively manage their learning processes and engage in strategic problem-solving are more likely to develop autonomous cognitive behaviors.

Reflective thinking also contributed significantly to cognitive independence,

suggesting that learners benefit from opportunities to evaluate their experiences critically and identify areas for improvement.

The positive contribution of multilingual ability reinforces the view that linguistic diversity may support cognitive flexibility and independent thinking. Academic performance also influenced cognitive independence, although its effect was comparatively smaller.

5.7 Findings from Reflective Journals

Qualitative analysis of reflective journals revealed several recurring themes.

Theme 1: Increased Confidence in Independent Learning

Many participants reported greater confidence in managing learning tasks independently.

One student noted:

"Initially, I depended heavily on my teachers for guidance. After participating in the activities, I realized that I could analyze problems and find solutions on my own."

This statement illustrates the gradual development of learner autonomy and self-confidence.

Theme 2: Enhanced Critical Thinking

Students frequently described improvements in their ability to evaluate information critically.

Participants reported becoming more aware of alternative viewpoints and learning to justify their decisions using evidence and logical reasoning.

Theme 3: Greater Awareness of Learning Strategies

Several learners acknowledged increased awareness of their own learning processes. Students described setting goals, monitoring progress, and adjusting study strategies when difficulties arose.

These reflections demonstrate growth in metacognitive awareness and self-regulated learning.

5.8 Classroom Observation Findings

Classroom observations provided additional evidence regarding the effectiveness of the assessment framework. Researchers observed increased learner participation over time.

Students demonstrated:

- Greater willingness to ask questions.
- Improved engagement in discussions.
- Enhanced collaboration during problem-solving activities.
- Increased initiative in completing learning tasks.
- More frequent use of reflective reasoning.

The observations suggest that the assessment framework encouraged active participation and independent intellectual engagement.

Notably, students from traditionally underrepresented backgrounds became more involved in classroom discussions as the study progressed. This finding indicates that culturally responsive assessment practices may help reduce barriers to participation and promote educational inclusion.

5.9 Findings from Semi-Structured Interviews

Interview data provided deeper insights into learners' experiences.

Perceptions of Independence

Most participants reported a stronger sense of ownership over their learning.

Students expressed appreciation for assessment activities that allowed multiple approaches to problem-solving rather than requiring a single correct answer.

Appreciation of Diversity

Many learners stated that interacting with peers from different cultural and linguistic backgrounds broadened their perspectives.

One participant explained:

"Working with students from different backgrounds helped me understand that there are many ways to approach a problem."

This finding highlights the educational value of cultural diversity in promoting cognitive growth.

Reduced Fear of Failure

Several students reported that the assessment framework reduced anxiety associated with traditional examinations.

Because the framework emphasized reasoning processes rather than memorization, learners felt more comfortable expressing their ideas and experimenting with solutions.

5.10 Discussion

The findings of the study demonstrate that cognitive independence can be effectively developed and assessed through innovative, culturally responsive assessment frameworks. The substantial improvement in post-test scores suggests that learners benefited significantly from assessment practices emphasizing autonomous reasoning, reflection, and problem-solving. The results align with constructivist learning theories, which view learners as active participants in knowledge construction. By engaging students in authentic tasks requiring independent judgment and critical evaluation, the assessment framework created opportunities for meaningful cognitive development.

The strong relationship between self-regulated learning and cognitive independence supports Zimmerman's theory of self-regulated learning. Learners who actively planned, monitored, and evaluated their learning demonstrated higher levels of autonomous thinking and intellectual responsibility.

The findings also highlight the importance of cultural diversity as a resource for cognitive development. Multilingual learners exhibited particularly strong performance, suggesting that exposure to

diverse linguistic and cultural experiences may enhance cognitive flexibility and independent reasoning.

Furthermore, the study confirms the limitations of traditional assessment methods that focus primarily on factual recall. The innovative framework captured a broader range of cognitive abilities, including reflection, strategic thinking, and decision-making. Such multidimensional assessment approaches provide a more comprehensive understanding of learner capabilities.

The qualitative findings reinforce the quantitative results by illustrating how learners experienced increased confidence, autonomy, and engagement throughout the assessment process. Students perceived the framework as fair, inclusive, and supportive of diverse perspectives, thereby contributing to a more positive learning environment.

Overall, the findings suggest that innovative assessment frameworks can play a significant role in promoting educational equity. By reducing cultural bias and recognizing multiple forms of cognitive competence, such frameworks provide diverse learners with meaningful opportunities to demonstrate their intellectual strengths.

The analysis revealed significant improvements in cognitive independence across all dimensions measured by the assessment framework. Strong relationships were observed between cognitive independence, self-regulated learning, reflective thinking, and problem-solving competence. Multilingual learners demonstrated particularly high levels of cognitive independence, highlighting the potential benefits of cultural and linguistic diversity. Qualitative findings further confirmed increased learner autonomy, confidence, and engagement. Collectively, the results demonstrate the effectiveness of the innovative assessment framework in fostering and evaluating cognitive independence among culturally diverse learners while supporting broader goals of inclusion, equity, and educational excellence.

6.CONCLUSION

The present study set out to investigate cognitive independence among culturally diverse learners through the implementation of an innovative assessment framework designed to evaluate autonomous reasoning, critical thinking, self-regulated learning, reflective thinking, decision-making ability, and problem-solving competence. The findings provide compelling evidence that cognitive

independence is not only a measurable educational outcome but also a developmental construct that can be effectively nurtured through inclusive, learner-centered, and culturally responsive assessment practices. As educational institutions continue to face the challenges and opportunities associated with increasing diversity, the importance of understanding and supporting cognitive independence has become more significant than ever before.

One of the most important conclusions emerging from this study is that cognitive independence can be substantially enhanced when learners are provided with opportunities to engage in authentic, reflective, and self-directed learning experiences. The significant improvement observed between pre-test and post-test scores demonstrates that assessment frameworks extending beyond traditional examination practices can positively influence learners' cognitive development. Rather than emphasizing memorization and passive reproduction of information, the innovative framework encouraged learners to analyze situations critically, evaluate alternatives, justify decisions, and take responsibility for their own learning processes. These experiences contributed to measurable growth in intellectual autonomy and independent thinking.

The study also confirms that cognitive independence is a multidimensional construct encompassing several interrelated competencies. Autonomous reasoning, critical thinking, reflective learning, self-regulation, decision-making, and problem-solving were found to function collectively in supporting learner autonomy. Improvements across all dimensions indicate that cognitive independence should not be viewed as a single isolated skill but rather as an integrated set of cognitive and metacognitive abilities that enable individuals to engage effectively with complex learning situations. Consequently, educational institutions seeking to cultivate independent learners must adopt comprehensive approaches that address these multiple dimensions simultaneously. Another significant conclusion relates to the role of self-regulated learning in fostering cognitive independence. The findings revealed strong relationships between learners' ability to plan, monitor, and evaluate their learning activities and their overall cognitive independence. Students who demonstrated higher levels of self-regulation were more likely to exhibit autonomous reasoning, effective decision-making, and successful problem-solving behaviors. This finding reinforces contemporary educational theories that emphasize learner agency and personal

responsibility in the learning process. It suggests that educators should intentionally incorporate activities that promote goal setting, self-monitoring, reflection, and strategic learning in order to strengthen cognitive independence among students.

The results further demonstrate the important influence of reflective thinking on cognitive development. Learners who regularly engaged in reflection were better able to evaluate their experiences, identify strengths and weaknesses, and make informed adjustments to their learning strategies. Reflective thinking encouraged deeper cognitive engagement and helped learners move beyond surface-level understanding toward more sophisticated forms of reasoning and judgment. The reflective journals used in this study provided valuable opportunities for students to examine their thought processes and become more aware of how they approached learning tasks. This awareness contributed significantly to the development of cognitive independence and highlights the educational value of reflective practices in diverse learning environments.

One of the most noteworthy findings of the study concerns the relationship between cultural diversity and cognitive independence. The results indicate that cultural and linguistic diversity can serve as

important assets in promoting cognitive growth. Multilingual learners demonstrated particularly high levels of cognitive independence, suggesting that exposure to multiple languages and cultural perspectives may enhance cognitive flexibility, adaptability, and critical reasoning. These findings support growing evidence that diversity enriches educational experiences by exposing learners to alternative viewpoints, encouraging perspective-taking, and stimulating deeper intellectual engagement. Rather than viewing diversity as a challenge to educational effectiveness, institutions should recognize it as a valuable resource capable of fostering higher-order cognitive development.

The study also highlights the importance of culturally responsive assessment practices in promoting educational equity. Traditional assessment methods have often been criticized for privileging certain cultural norms and forms of knowledge while overlooking the strengths and experiences of diverse learners. The innovative assessment framework employed in this study was designed to minimize cultural bias and provide multiple opportunities for students to demonstrate their cognitive abilities. The positive outcomes observed across different learner groups suggest that culturally responsive

assessment can contribute to more equitable evaluation practices and provide a more accurate representation of students' intellectual capabilities. Such approaches are particularly important in multicultural educational settings where learners bring varied experiences, perspectives, and ways of knowing.

Furthermore, the findings demonstrate that authentic and performance-based assessment strategies are more effective in capturing cognitive independence than conventional testing methods. By focusing on reasoning processes, problem-solving approaches, and reflective thinking rather than solely on factual recall, the framework provided a richer and more comprehensive understanding of learner competence. Students reported feeling more engaged, confident, and motivated when assessment tasks allowed them to explore ideas independently and apply knowledge in meaningful contexts. These findings suggest that educational institutions should reconsider assessment practices that rely heavily on standardized examinations and instead adopt more holistic approaches that evaluate higher-order cognitive skills.

The qualitative findings provide additional support for the effectiveness of the innovative assessment framework. Students consistently reported increased confidence in their ability to think independently, make

decisions, and solve problems. Many participants described becoming more willing to express their opinions, question assumptions, and explore alternative solutions. Such outcomes are particularly significant because confidence and self-belief play important roles in sustaining lifelong learning and intellectual growth. Learners who perceive themselves as capable thinkers are more likely to engage actively in educational activities, pursue challenging tasks, and continue developing their cognitive abilities beyond formal educational settings.

From a pedagogical perspective, the study underscores the need for learner-centered educational practices that encourage autonomy, inquiry, and reflection. Teachers play a critical role in creating environments that support cognitive independence by providing opportunities for exploration, discussion, collaboration, and self-directed learning. Rather than serving solely as transmitters of information, educators must act as facilitators who guide learners in constructing knowledge, evaluating evidence, and developing independent judgment. Such pedagogical approaches are essential for preparing students to navigate the complexities of contemporary society and the rapidly changing demands of the global knowledge economy.

The implications of this study extend beyond classroom practice to educational policy and curriculum development. Policymakers and curriculum designers must recognize cognitive independence as a fundamental educational objective and ensure that assessment systems reflect this priority. Curricula should incorporate opportunities for critical inquiry, reflective practice, problem-solving, and self-regulated learning across disciplines. Assessment frameworks should be designed to accommodate learner diversity and evaluate a broad range of cognitive competencies rather than focusing exclusively on content mastery. Such reforms can contribute to the development of more inclusive, equitable, and effective educational systems.

In conclusion, this study demonstrates that cognitive independence is a vital educational outcome that can be effectively cultivated through innovative and culturally responsive assessment frameworks. The findings provide strong evidence that learners from diverse backgrounds can develop higher levels of autonomous reasoning, critical thinking, self-regulation, reflective learning, decision-making, and problem-solving when provided with appropriate educational opportunities. The study further highlights the positive role of cultural diversity in enriching cognitive

development and emphasizes the need for assessment practices that recognize and value diverse forms of learner competence. By promoting cognitive independence, educational institutions can empower learners to become confident, reflective, and self-directed individuals capable of addressing the challenges of an increasingly complex and interconnected world. Ultimately, fostering cognitive independence is not merely an academic objective; it is an essential component of preparing individuals for lifelong learning, responsible citizenship, professional success, and meaningful participation in diverse global societies.

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ETHICAL DECLARATIONS

Ethics Approval and Consent to Participate

The study was conducted in accordance with accepted ethical standards for educational research. Prior permission was obtained from the heads of the participating institutions before data collection. All participants were informed about the objectives and procedures of the study, and their voluntary consent was obtained prior to participation. Participants were assured that their responses would be used solely for academic and research purposes. Confidentiality and anonymity were maintained throughout the study.

Consent for Publication

All participants provided informed consent for the use of anonymized data for research and publication purposes. No personally identifiable information has been disclosed in this manuscript.

Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no competing interests regarding the publication of this research.

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Authors' Contributions

Mr. S. Kumaran Arul Devaram (First Author) contributed to data collection, literature review, data analysis, interpretation of findings, and manuscript preparation.

Dr. S. Gunasekaran (Corresponding Author) conceptualized the study, designed the research framework, supervised the investigation, validated the findings, reviewed and edited the manuscript, and approved the final version for publication. Both authors read and approved the final manuscript.

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Declaration of Originality

The authors declare that this manuscript is original, has not been published previously, and is not under

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