KALAM International Research Journal
Faculty of Arts and Culture
South Eastern University of Sri Lanka
17(2), 2024

DESIGNING AN EFFECTIVE SCIENCE MODULE FOR ENHANCING CRITICAL THINKING IN SCHOOL STUDENTS: A STUDY ON CONCEPTUAL FRAMEWORK

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Abstract

There is a need of cultivating developmentally appropriate module that can be implemented in schools to improve Critical Thinking (CT) skills in children for establishing groundwork for continuous learning and innovations. Literacy in science infused with enhancement of CT skills can better serve the goal of critical thinkers. The object of this study is to create an instructional framework for a science module focused to enhance CT abilities in this crucial developmental stage. Upon instructional approach based on ADDIE model, the development process delineates the steps involved in development of the module. This paper offers a newly conceptualized framework for development of module that enhance CT in children, grounded in Constructive Alignment theory stemmed from constructivism and cognitive development theory. The framework articulates possible instructional strategies with appropriate activities and assessment. Within the proposed framework, it addresses the specific instructional methods that improves Critical Thinking through science learning, as a result of active engagement with teacher's scaffolding to gain a comprehensive learning experience. This study provides an innovative pedagogical blueprint to equip teachers to empower students as self-assured and independent critical thinkers.

Keywords: Critical Thinking, Module development, Constructive Alignment Theory, Instructional strategies, Inquiry-based learning

Introduction

The contemporary educational shift in paradigm commands learners enriched with Critical thinking (CT) skills to foresight complex scientific and societal issues. Although India's National Educational Policy (NEP) 2020 has been emphasizing CT and Experiential learning (National Education Policy 2020, n.d.), the country's historic underperformance on global assessments such as 72 nd out of 74 nations in the PISA Science literacy evaluation underscores the persistence of systemic challenges. Recent national-level assessments such as National Achievement Survey (NAS) 2021, revealed the continuing disparities in academic discipline of science education within the Indian context. The NAS report showed that merely 36% of Grade 10 students demonstrated proficiency in science with the substantial gap between urban and rural areas, in which latter underperformed the former with a margin of 12% points (NAS REPORT-CARD, n.d.). These systemic gaps show failure to bridge the divide between policy aspirations and classroom realities, highlighting the disconnect between the aspiration set in curricular framework and the realities in practical limitations of pedagogical implementation.

ISSN (Print): 1391-6815 *ISSN (Online): 2738-2214*

India's science education system is marked by content-heavy curricula relying on high-stakes examination and teacher-centered pedagogies that insist rote memorization over inquiry learning. It is found that most science teachers rely solely on lecture methods with limited emphasis on inquiry, experimentation or problem-solving (NCERT, 2007). In addition, lack of functional laboratories in 30% of rural secondary schools and poor digital access for resource accounts for 42% of marginalized communities as mandated by NEP 2020. Moreover, teacher-training programs such as those on governmental platform like DIKSHA, frequently fail to adequately integrate CT skills leaving the educators unsuitable for encouraging analytical reasoning or application of concepts in real-world situations. Socio-economic disparities further intensify the challenges in science education. As per ASER centre (2023) report, 52% of adolescents in rural areas lack the ability to explain basic scientific concepts, reflecting gaps in their foundational understanding. Conversely, the urban-private education system, although better- resourced, has a parallel crisis with an excessive focus on excelling in competitive engineering and medical entrance examinations. This makes science education a superficial approach focused on problem-solving restricting creativity. These perspectives unveil a systemic contradiction, an education framework that strives for global innovation competitiveness while contending with pedagogical approaches that hamper the CT competencies essential for attaining this objective.

CT is essential for scientific inquiry, that equips learners with the ability to analyze data, assess the evidence and derive conclusions. Previous researches highlights that integrating CT into science instruction enhances intellectual curiosity, academic achievement and prepares students for STEM-related career path. Nevertheless, CT is often regarded as an implicit outcome rather than a teaching skill. A meta-analysis by Abrami et al. (2015) found that explicit CT in science classes increased student's achievement by 0.45 standard deviations which a substantial increase due to the integration. Despite the fact that traditional science teaching focuses on delivery of content and rarely includes activities that prompt learners to question assumptions, design experiment or critique arguments. This Pedagogical lacuna is particularly pronounced in regions where high-stakes examinations prioritize the recall of factual knowledge rather than development of higher-order cognitive skills.

In India's diverse educational settings, there is a lack of instructional modules grounded in empirical research to address the systemic challenges by merging structured pedagogy with science. Integrated modules can cater the needs of diverse learners by embedding science content with self-paced activities and assessments, which is crucial for heterogeneous classrooms with linguistics, cognitive and regional disparities. By integrating evidence-based practices like contextualized CT activities and scaffolding tasks, the module can democratize with quality education outcomes without undermining academic rigor. Although potentially powerful, poorly designed module may risk perpetuating existing disparities. Most of the Indian regions lack standardized framework to guide module development leading to materials that are either too much theoretical or lacking in pedagogical substance. Overall, these stances underscore the urgency for evidence-based framework that ensure modules are both conceptually grounded and practically effective.

Objectives

The objective of the study is:

To develop an instructional framework to develop science module to enhance the CT skills for upper primary students at selected school in Tamil Nadu, India.

ISSN (Print): 1391-6815 *ISSN (Online): 2738-2214*

Literature Review:

CT is a fundamental skill for scientific literacy, enabling learners to analyse evidence, evaluate arguments, and solve complex problems. For learners of age group 11-12 years, who are at the significant stage of cognitive and metacognitive development, strengthening CT through science education is critical. This review culminates literature on pedagogical frameworks for CT development, instructional strategies for contextualizing science content, and methodologies for validating science modules. The aim is to identify evidence-based strategies that inform the design and development of a science module tailored to enhance CT skills in Upper primary students.

In the context of science, CT embodies abilities such as interrogating assumptions, interpreting empirical data, formulating evidence-based inferences, and contemplating potential biases (Facione, 1990). The development of CT skills in adolescents corresponds with their cognitive transition from Piaget's concrete operational stage to the formal operational stage, during which they begin to show abilities in abstract reasoning (Piaget & Inhelder, 1958). Nevertheless, CT skills do not develop spontaneously; they demand purposive instructional approaches (Abrami et al., 2015). Existing research underscores that middle school science curricula commonly prioritize the delivery and imparting the factual knowledge over the development of advanced cognitive abilities (Hofstein & Lunetta, 2004). A meta-analysis conducted by Huber & Kuncel (2016), reveal that explicitly teaching CT skills significantly enhances cognitive ability of students across diverse domains. This also stresses the necessity of incorporating modules that explicitly focus on development of CT skills within the curriculum. Moreover, the design of the module aligns with the National and International standards of education that prioritize CT, particularly Next Generation Science Standards (NGSS).

The development of guidelines and strategies to support effective Teaching & Learning and to enhance learning experience has been always a fundamental aspect of educational progress. The central aim of the curriculum development is to recognise the needs of the students has led to innovations in teaching models and instructional approaches. Tracing back to 20th century, the systematic development of curriculum approaches and strategies have been influenced by pioneers in reformation of education such as John Dewey. The Philosophy of John Dewey insisted the experiential learning, and its importance lies in the student-centred education, arguing that meaningful learning can only occur when the students are engaged actively with their environment (Dewey, 2024). This principle remains as an integral part of contemporary education and also involves in the shaping the designing process of curricula to prioritize contextual understanding with learners' engagement.

The arousal of a crucial phase in curriculum development in the mid-20th century with Ralph Tyler's introduction of "Tyler Rationale". He proposed a method which is systematic in emphasizing the definition of clear objectives, the selection of learning activities appropriately with their logical organization and the evaluation of learning outcomes (Kliebard, 2004). This model laid a framework for the alignment of the instructional practices with measurable objectives, setting the groundwork for subsequent instructional theories. Tyler's influence has shown persistence in modern curriculum design especially on the outcome-based education. In the time of 1960s and 1970s, education undergone a shift in paradigm towards defining specific, measurable learning objectives to cater the needs of evolving societal and technological demands. This shift catalysed the development of frameworks for module creation that enabled the personalized and competency-based learning. One such influential model is ADDIE, developed by Florida State University to standardize the

ISSN (Print): 1391-6815 *ISSN (Online): 2738-2214*

processes in instructional design (Molenda, 2003). ADDIE model which encompasses Analysis, Design, Development, Implementation and Evaluation, remains one of the most widely adopted instructional design method. The advantage of its flexibility and iterative structure allows curriculum designers and policy makers to effectively design, deliver and refine the instructional materials to cater the needs of the learners.

The integration of technology into education in the late 20th century and early 21st centuries transformed the module development into greater extent. Digital tools and platforms expanded the scope of instructional design enabling the learners to develop CT, collaboration and problem-solving skills beyond the subject knowledge. For instance, Merrill's First Principle of instruction highlights the significance of task-centred and problem-based learning establishing that modules address real world challenges effectively (Merrill, 2002). The ongoing evolution of module development includes innovations in technology, evidence-based practices and theories in contemporary Pedagogy. Hereby, adaptive learning system powered by artificial intelligence facilitate real-time feedback and personalized learning pathways (Siemens, 2013). To conclude, Instructional design continues to evolve, adapting the needs of the learners and educators in an ever-changing educational landscape.

The translation of frameworks into practical modules emerges as a second layer of complexity: ensuring these resources are pedagogically sound, relevant, and adaptable. While curriculum validation has traditionally focused on content accuracy (Aiken, 1985), modern education demands a more holistic approach. For example, modules must align with institutional goals, cultural contexts, and diverse learner needs (Banks, 2015). The need for systematic and rigorous approach is highly emphasized in guiding the process of selecting and utilizing content experts for research instrument. Possibility of error can arise when the process is not planned systematically. The initial stage includes defining the construct domain, generation test items, and constructing the assessment instrument. This process varies for cognitive and affective measures. For an affective measure, a comprehensive literature review is to be conducted to identify the dimension and sub-dimensions of the construct under investigation whereas for cognitive assessment, a table of specifications is employed to identify the content domain which is then sampled to the generation of test items.

Methodology

This study utilizes the Design and Development Research (DDR) Methodology, with a specific focus on the construction of a framework to design a science module as an intervention. The methodology involved three phases, namely needs analysis, theoretical grounding and framework drafting and iterative validation on evaluating the instructional materials, tools or programs to address specific educational challenges (Richey & Klein, 2014). This approach often employs a multi-phased methodological approach comprising of initial needs analysis assessment, the DDR approach which is iterative leading to refinement of the module for effective implementation and evaluation. Through an extensive review of scholarly literature and consultation with the subject matter experts, the theoretical basis and design principles of the framework were developed. The preliminary version subsequently refined through an iterative process involving experts' opinion and references made through comparative analysis of prior frameworks in similar interventional studies. As a result, a pedagogical framework was created to design this science module to produce a context-specific and subject-specific to achieve the learning outcomes. This final framework which is refined to align with the aims and structure of a module, provided a validated blueprinted for module development, balancing rigor in theoretical foundations with adapting pragmatically. Although this study prioritized the development of the conceptual

ISSN (Print): 1391-6815 *ISSN (Online): 2738-2214*

framework, forthcoming research will expand to encompass the implementation and assessment of the module's impact in enhancing the learner's CT skills.

Results and Discussions

This study is grounded in foundational instructional design which then conceptualized into context and subject-specific framework for the enhancement of CT in school children.

Module Design Principle

The design principle of this module is rooted in the specific context of this study, which focuses on enhancing the CT skills through science teaching among the upper primary students in Tamil Nadu, India. This Critical Thinking Enhancing Science Module (CTESM) aims to improve conceptual understanding through inquiry-based learning leading to enhanced CT skill levels in students by aligning with state education frameworks and curriculum standards. It incorporates active learning emphasizing learner-centeredness, interactivity and adaptability to cater diverse needs. The ADDIE model consisting of five different phases of Analysis, Design, Development, Implementation, and Evaluation. Studies have empirically proved that the capacity of ADDIE model to cultivate CT abilities. Zulkifli et al. (2018) showed that module developed based on ADDIE demonstrated its utility in developing a philosophical Inquiry approach in moral education leading to enhanced critical thinking outcomes among the secondary school students.

Analysis

In **Analysis** phase, the model insists on the comprehensive assessment of learners' characteristics, their cognitive abilities and gaps in CT skill acquisition, ensuring that the instructional strategies are aligned to their developmental stage. This aligns with the Piaget's theory of cognitive development, predominantly the concrete operational stage, in which the learners commence logical reasoning but in need of structured guide to comprehend abstract concepts (Huitt & Hummel, 2003).

As a part of analysis phase, the researcher thoroughly analysed the curriculum of upper primary science and textbook prescribed by the state board of education. Alongside, the curriculum content, structure and its alignment with pedagogical objectives are also assessed to examine the ability of student's educational needs. Furthermore, the analysis of lesson plans developed by the teachers for curriculum delivery are also assessed. These plans are structured spanning annually, term-wise, monthly and daily formats. Despite these systematic planning, classroom observations revealed that instructional methods predominantly focused on lecturing and making the students to sit quietly without moving from their seats were common scenario. Hands-on activities which is essential for science teaching were notably lacking. This teaching approach appeared to be training-based, where the students were encouraged to be memorizer and repeat the content rather than engaging in exploration and Inquiry activities. Classroom observations and informal discussions with students provided insights into their interest in learning science and level of questioning the content they learned. Upper Primary students in the selected school were grouped into six sections based on their date of admission, learning abilities and proficiency in language along with their choice of second language. Based on the teaching style employed by the science teachers, behaviour and participation of the students varied significantly was obvious through the classroom observations. While the small proportion of students were seen attentive through answering the teachers' questions, the majority exhibited passive conduct and encountered difficulties in maintaining

ISSN (Print): 1391-6815 *ISSN (Online): 2738-2214*

attention. Across all of 6 sections, teachers struggled with large class-size, most exceeding 40 students. The high-student ratio imposed substantial strain on the teachers, affecting the ways to conduct interactive sessions with Hands-on activities, group activities. Despite the teacher's effort to maintain classroom order, the constraint in differentiated instructions and innovative pedagogical approaches greatly affected the students' overall engagement and Learning outcomes.

Design

The phase of Design focuses on the SMART objectives that target key CT components such as analysis, evaluation, synthesis as highlighted by Facione (1990). This involves carefully crafting well-defined, measurable, achievable, relevant and time-bound objectives to develop the module and smooth implementation in the real classroom environment. By the alignment of objectives of CT skill with objectives of module, the researcher ensures that the module aimed to enhance students' ability to analyse information, evaluate the information with evidence, thereby leading to synthesize new ideas. In this study, Design phase serves as a detailed blueprint that transforms the findings of Analysis phase into instructional plan in a comprehensive manner. The primary aim of this module to enhance CT skills through strategies that are learner- centred, inquiry-based, improve cognitive understanding. Moreover, it was developed as supplementary material to facilitate the teachers and students aligning with the Tamil Nadu Science Framework. This module design was carefully curated to make an organized and relevant materials allowing conceptual understanding to build progressively from the foundational level to advanced level. Furthermore, the scaffolding ideas for the teachers are provided in every single lesson plan to tackle the learning needs of students in each level as they are categorized into Struggling, Average and Advanced students.

Development

In the phase of Development, ADDIE facilitates the creation of relevant materials, engaging activities which are contextually appropriate for the instruction. This includes developing facilitating content like teaching and learning strategies with its steps, hands-on activities, worksheets, assessments and CT questions. Abrami et al. (2015) research underscores the strategies that encourages the students with the skills to question assumptions, analyse complex situation and make decisions thereby making them prepared for life-long learning and democratic participation. This is made possible by teaching with Inquiry-based learning that cultivates CT by engaging students in meaningful, problem-oriented and reflective practices.

Implementation

The phase of Implementation provides the module is tested in classrooms with real-world applications, providing insights into its possibilities and effectiveness. During this phase, the integration of module into T & L process that allows for direct interaction with learners. This phase stresses the importance of training session for teachers to ensure feasibility of implementation, as emphasized by Guskey (2002) , who stressed the significance of teacher preparedness maximise the impact on the instructional strategies. Pilot testing is also conducted by gathering initial observations, analysing classroom dynamics and collecting feedback from teachers and students. This real-time process will assist in identification of strengths and weaknesses that make way for the areas of improvement leading to relevance of module and adaptability to the context of the classroom environment (Branch, 2009).

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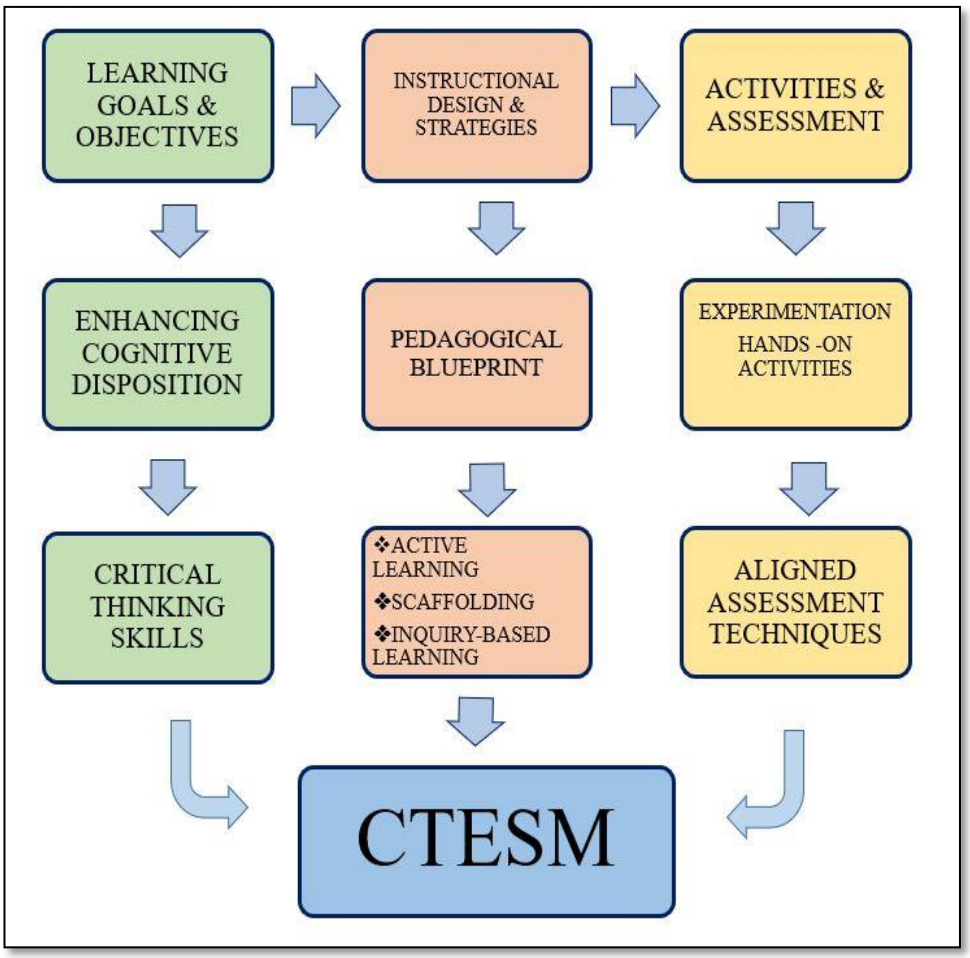
Module Framework for CTESM

Based on the design principle and theoretical foundations for the module, the researcher developed a framework for the CTESM (Figure 1) as a layout of the design and development for the module. The module focuses on the enhancement of CT skills through the teaching of science. Integrating CT skills into academic subjects has become more achievable due to the shared instructional methodologies between science and CT pedagogy. Drawing on the study's theoretical framework, which serves as a strong foundation for the structure of the module designing and development enabling its effective implementation. Moreover, these theories aid in contextualizing the aims of the module, facilitating the translation of theories into practice to achieve the intended learning outcome.

Figure 1: Framework of the Critical Thinking Enhancing Science Module (CTESM)



The framework contains three key components: Learning Goals and Objectives, Instructional Design and Strategies, Activities and Assessment. Each of these key components serve as the foundational structure to facilitate the systematic knowledge-building process. To address the function of each of these components, it is further detailed below:

Learning Goals and Objectives

In the context of CTESM, aligning instructional strategies with learner's prior knowledge and experience manifests as an influential element to the success of module's initiatives. At the core of the framework is the Learning Goals and Objectives, which serve as the foundation for integrating the constructs from the well-established theories with empirical evidence. This key component is instrumental in enabling the process of data collection and analysis systematically, thereby favouring critical insight into instructional approaches and active engagement of students. This component strives to bridge the gap between the theoretical and practical implementation, the learning goals and objectives not only enhance the effectiveness of pedagogical practices but also guide the development of the targeted intervention. A comprehensive examination of this component will yield a valuable opportunity to tackle the current issues in education and steadily aids in advancing ongoing discourse surrounding effective teaching and learning strategies.

Enhancing a cognitive disposition is characterized by synchronized inquiry and evaluation is fundamental in developing CT skills in academic settings. This disposition is conceptualized by Facione (1990) highlights Analysis, Inference, Evaluation as core subskills. This empowers the learners to actively engage with content instead of passively consuming information (Halpern, 1998). Learners who incorporate this mindset approach learning as an active, iterative cycle of processes, systematically deconstruct problems that are complex, verify with underlying assumptions and synthesize diverse perspective to build on evidence-based arguments (Paul & Elder, 2006). This type of approach cultivate rigor in intellectual growth, turnout academic challenges into opportunities for growth and advancement in key objectives such as independent reasoning and innovative problem-solving (Abrami et al., 2008).

Incorporating these dispositions into pedagogical framework ca directly support the objectives by cultivating leaning environments in which the tasks are subjected to strenuous examination, rather than just completed in a routine manner. Previous studies yield empirical evidence that students with strong CT disposition show enhanced academic performance, as they allow students to apply their metacognitive skills to restate their own comprehension and communicate their findings with accuracy (Ku, 2009). Furthermore, Dewey's emphasis on the practising reflective inquiry shows how systematic way of inquiry equips students with transferable reasoning skills, preparing them for life-long learning and the apply it in the real-life situations (Learn, 2000). By prioritizing the reinforcing the cognitive disposition through well-structured objectives based on distinct goals, educators can excel in development of instructional approaches that inculcate the students' capabilities to be curious learners, empowering intellectual growth and grow as a sustained problem-solver in real life.

Instructional Design & Strategies

In this framework designed exclusively for module, Instructional Design and Strategies serve as critical component built on the foundational component – Learning Goals and Objective, which involved in systematically transforming learning theories into effective educational transformations. Instructional Design (ID) conceptualized within the lens of educational research, integrates insights from various academic discipline and leverages well-established theories and empirically data-driven approach to cater the needs of the learners to optimize educational outcomes. On the other hand, Instructional Strategies encompass empirically validated methods and techniques derived from systematic investigation, theoretical framework and rigorous inquiry. These strategies are purposefully designed to align with diverse levels of student's needs drawing on principles

ISSN (Print): 1391-6815 *ISSN (Online): 2738-2214*

from psychology, education and domain-specific scholarship. These strategies embody evidence-based approaches on "how" of teaching and grounded in scientific understanding of how learning occurs.

ID function as a structured, evidence-based approach to nurture the cognitive disposition and CT by aligning pedagogical strategies with explicit learning objectives (Merrill, 2002). Grounded in the Analysis, Design, Development, Implementation and Evaluation (ADDIE) model, this process commences with examination of learner's existing knowledge and contextual requirements, thereby enabling the coherence between instructional objectives and targeted cognitive outcomes (Reiser & Dempsey, 2012). This design phase insists the scaffolding techniques informed similar to Vygotsky's ZPD, which structures events in learning processes to progressively withdrawing the learner dependency while fostering metacognitive reflection (Hmelo-Silver et al., 2007). Instructional strategies that inculcate active engagement through task such as problem-solving tasks and peer-discussion are integrated purposely to induce HOT skills. This enables students to synthesize abstract ideas and apply them to novel contexts (Freeman et al., 2014).

ID and Strategies together informs the proceeding key component – Pedagogical Blueprint, which act as road map to integrate inquiry-based models such as 5E Instructional Model (Bybee, 2006) to foster CT skills systematically. This instructional model – Engage, Explore, Elaborate, Evaluate and Evaluate sequenced to provide a structured learning structure that scaffold the students with conceptual understanding through process of hypothesis testing and evidence-based reasoning skills. Empirical research by Furtak et al. (2012) has shown to be associated with findings with enhanced analytical skills. Another model holds the significant part in the pedagogical blueprint of the study is the Guided- Inquiry model, which operationalize the critical disposition by placing learners take the role of investigators, inducing them to construct new knowledge through systematic questioning, receiving feedback from the peers and a process of hypothesis testing. This approach makes learners to hold ownership of their learning through engaging in a cycle of inquiry, gathering relevant evidence and to collaborate in groups to build understanding (Kuhlthau et al., 2015). Furthermore, the Concept Attainment Model (CAM) grounder in Bruner's constructivist theory, refine the ability to think critically by guiding learners to discern patterns conceptually through analysis of examples and non-examples. By engaging in formulation of hypothesis, classifying and refinement of definitions, the model enhances inductive reasoning and schema development aligning with the objective of cultivating analytical reasoning. This flexible approach, though structured yet adaptable design that integrates seamlessly with various pedagogical approaches (Bruner, 1974).

Reflecting on the pedagogical blueprint, operationalizing active learning, structured scaffolding, and Inquiry-Based Learning approaches through the Concept Attainment Model, 5E instructional Model and Guided-Inquiry model of the framework bridges the theoretical concepts with transformative classroom activities. This synergistic approach prioritizes learning environment that promote CT skills and cognitive engagement, posits the framework as a foundation for advancing in both scholarly research activities and innovative in instructional practices. Moreover, this strategic integration of these instructional approaches not only promotes expertise in subject-matter but also cultivate the development of CT abilities.

ISSN (Print): 1391-6815 *ISSN (Online): 2738-2214*

Activities & Assessments

The third essential component of the framework CTESM- Activities and Assessments, that intersects the foundational theories and methodological rigor of the framework through practical application, ensuring the exploration of pedagogical strategies, learner engagement and educational outcomes.

The integration of activities and assessments systematically into learning framework is pivotal for cultivation of cognitive disposition and nurturing CT skills, aligning the principles of constructivism, cognitive development and empirical research on effective instructional practices. Contemporary research highlights that the well-structured learning activities combined with appropriate formative assessments, promote iterative process of reflections and application enables the learners to actively build upon their existing knowledge to understand the concepts (Learn, 2000). This kind of alignment cultivates metacognitive awareness, as learners engage in activities that compel them to utilize analytical reasoning, synthesis and evaluation which are the essential components of CT (Facione, 1990).

Hands-on activities based on PBL which are grounded in experiential learning approaches, motivate learners to apply the theoretical concepts on to real-world challenges. This approach strengthens the conceptual retention in learners and adaptative problem-solving (Freeman et al., 2014). Integrating formative assessment into hands-on activities through embedded feedback loops that shape learner's cognitive approaches and self-directed learning behaviours (Black & Wiliam, 1998; Hattie, 2008). The research finding by Hattie (2008) highlights providing iterative and timely feedback during the learning activities encourages learners to shift their focus from simply completing the tasks to a deeper metacognitive self-examination of their own learning processes. This supports the development of adaptive reasoning skills and self-regulation behaviours. Furthermore, Black & Wiliam (1998) posits that catering formative feedback during the hands-on activities encourages students to recognize the variance in their existing knowledge and targeted learning outcomes. This prompts them to revise the hypotheses in regard to their experimental approaches or redesign their choices.

Biggs (1996) underscores the significance of activities that encourage students to construct knowledge actively, that resonates with the focus on refining cognitive strategies. Additionally, he argues that assessments should not only be measure outcomes, but it should improve learning, which is accordance with the idea that formative assessments intensify pedagogical values. Aligned Assessment Techniques that align with the learning objectives such as IBL and other performance-based task and its evaluation supports in reinforcing the development of advancing cognitive skills by ensuring compatibility between what is being assessed and what is being taught. Research by Wiggins (1998) shows that when assessment s reflects authentic, context-rich challenges, it not only evaluates competence but also improve learners' ability to apply knowledge among different contexts. Furthermore, Ambrose et al. (2010) underscores the compatibility between instructional activities and assessment techniques promotes a coherent learning condition that scaffolds CT through deliberate practice and metacognitive reflection.

This integrated approach in developing the module CTESM validated upon the empirical evidence on active learning highlights the significance of incorporating both cognitive and practical learning experience into curricular design to drives the enhancement of CT skills and other related transformative educational outcomes.

ISSN (Print): 1391-6815 *ISSN (Online): 2738-2214*

Conclusion

This study revealed that the Constructivist theory and Cognitive Development theory are congruous and well aligned with contemporary need for developing reasoning skills and scientific inquiry. Furthermore, incorporating the Constructive alignment theory provides a reinforcement to make theory into practice by systematic execution of module content with activities and assessment for the enhancement of the CT skills. Together, these interrelated theoretical perspectives not only make up the gap in the existing body of knowledge but also offer innovative ways to design curricula that foster deep, reflective and analytic thinking. The science module CTESM contributes a practical way to engage the students actively with the teachers scaffolding in varied degrees to cater the diverse learners. The strategies involving conceptual understanding, exploration of concepts and inquiring the evidence to construct new knowledge makes this module a comprehensive framework to design learner-centered lesson plans

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