Diving into Cognitive Demands for Establishing Learning Objectives through Applied Cognitive Task Analysis

Nurul Fitriah Alias[1*], Rafiza Abdul Razak[2]

[1]Faculty of Education, Universiti Teknologi MARA, UiTM Puncak Alam Campus,
42300 Puncak Alam, Selangor, Malaysia
nurulfitriah@uitm.edu.my
[2]Department of Curriculum and Instructional Technology, University of Malaya,
50603 Kuala Lumpur, Malaysia
rafiza@um.edu.my
[*]Corresponding Author

https://doi.org/10.24191/ajue.v21i1.27

Received: 4 December 2024
Accepted: 2 February 2025
Date Published Online: 30 June 2025
Published: 30 June 2025

Abstract: This study explores the application of Applied Cognitive Task Analysis (ACTA), namely task diagram and knowledge audit, to dissect the intricate cognitive demands and skills underlying the establishment of learning objectives. Through meticulous examination of cues, strategies, and the challenges encountered, this study illuminates the cognitive processes involved in setting learning objectives. The methodology involved eliciting detailed cognitive processes from experts, shedding light on the underlying mechanisms of formulating learning objectives. By leveraging ACTA techniques, this research unveils essential insights into the cognitive dimensions of establishing learning objectives, offering implications for instructional design, training, and educational research. The findings reveal a systematic process for establishing learning objectives, including identifying learning needs, defining objectives, aligning with curriculum standards, considering learners' needs and abilities, developing assessment strategies, providing feedback mechanisms, implementing objectives, and evaluating and refining them. These findings offer valuable insights into the cognitive aspects of learning, with implications for instructional design, training, and educational research. This research contributes to the growing body of literature on ACTA and its utility in understanding complex cognitive tasks such as formulating learning objectives.

Keywords: Applied Cognitive Task Analysis (ACTA), Cognitive Demands, Knowledge Audit Learning Objectives, Task Diagram

1. Introduction

Learning objectives are fundamental components of educational and training programs, serving as guideposts for both learners and instructors. They articulate the intended outcomes of instruction and provide a roadmap for designing, delivering, and evaluating learning experiences (Orr et al., 2022; Sewagegn, 2020). Without clear and well-defined learning objectives, educational efforts may lack direction and coherence, leading to suboptimal outcomes. In educational settings, learning objectives inform curriculum development, instructional design, and assessment strategies. They help educators identify the knowledge, skills, and competencies that learners are expected to acquire, allowing for the development of targeted instructional materials and activities. Additionally, learning objectives provide learners with a sense of purpose and direction, motivating engagement and facilitating self-regulated learning. When educational efforts lack clear objectives, it becomes more challenging to align teaching

content and methods with students' interests and learning needs. This misalignment can lead to disengagement and decreased motivation among students, as they may struggle to see the relevance or meaning behind school activities (Solari, Vizquerra & Engel, 2022). Consequently, students may fail to derive meaning from their educational experiences, resulting in suboptimal outcomes such as poor academic performance or disaffection with learning.

Similarly, in workplace training programs, learning objectives play a crucial role in aligning training activities with organizational goals and performance expectations. Arulsamy et al. (2023) highlighted that training and development are essential mechanisms employed to optimize employee performance within the organizational context. This implies that training initiatives should align with the broader organizational goals and objectives to maximize their effectiveness. By clearly defining learning objectives, employers can ensure that training initiatives address specific skill gaps and competency requirements, ultimately enhancing employee performance and productivity.

However, the effective establishment of learning objectives requires a thorough understanding of the cognitive demands and skills involved in the target domain. This understanding goes beyond surface-level descriptions of learning outcomes and delves into the underlying cognitive processes that enable learners to achieve those outcomes. This is where Applied Cognitive Task Analysis (ACTA) comes into play. ACTA provides a systematic framework for uncovering the cognitive demands and skills required to perform complex tasks (Militello & Hutton, 1998). By employing various interview methods, such as task diagrams, knowledge audits, simulation interviews, and cognitive demands tables, ACTA enables researchers to explore the intricate cognitive processes involved in task performance. This in-depth analysis allows for the identification of key cognitive factors that influence learning and performance, thus informing the development of more effective instructional strategies and interventions.

Recent research emphasizes the significance of aligning learning objectives with instructional activities to optimize learning outcomes. For instance, Gray and DiLoreto (2016) demonstrated that clear and specific learning objectives are associated with increased learner engagement, satisfaction, and comprehension in courses. Sewagegn (2022) further underscored the importance of educators possessing the skill to craft clear and meaningful learning objectives within academic settings. Moreover, effective alignment between learning objectives and assessments emerges as a critical factor in fostering student learning success.

Similarly, Brown et al. (2022) found that aligning learning objectives with workplace training activities improves skill acquisition and job performance among employees. These findings underscore the critical role of learning objectives in facilitating effective learning experiences across various domains and underscore the need for a deeper understanding of the cognitive processes underlying their establishment.

In summary, learning objectives are essential components of educational and training programs, guiding instruction and assessment efforts. The effective establishment of learning objectives requires a comprehensive understanding of the cognitive demands and skills involved, which can be achieved through the application of ACTA methodologies. Recent research supports the importance of clear learning objectives in enhancing learning outcomes, underscoring the significance of your research in contributing to this body of knowledge.

1.2 Overview of Applied Cognitive Task Analysis (ACTA)

Applied Cognitive Task Analysis (ACTA) stands as a systematic and robust approach employed to dissect the intricacies of complex cognitive tasks (Militello, & Hutton, 1998). By scrutinizing the underlying cognitive processes, ACTA provides valuable insights into the cognitive demands and skills required to accomplish tasks effectively. This methodology has gained prominence across various fields, including education (Alias, 2025; Wahid et al., 2023; Idris et al., 2022), training (Gore, Banks, & McDowall, 2018), healthcare (Graham et al., 2023; Russ-Jara et al., 2023), aviation (Seamster & Redding, 2017), and work operations (Knisely et al., 2021; Papautsky et al., 2020), owing to its ability to inform instructional design, training interventions, and performance improvement strategies. Furthermore, Swaby et al. (2022) concurred that this approach holds significant promise in improving the development, refinement, modification, and adaptation of complex interventions, clinical protocols, and practice guidelines.

Recent research underscores the versatility and efficacy of Applied Cognitive Task Analysis (ACTA) in unravelling the cognitive intricacies of diverse tasks. For instance, a study by Idris et al. (2022) in the field of e-training highlighted the utility of ACTA in identifying cognitive errors and e-training design and process difficulties faced by educators. By employing simulation interviews and cognitive demands tables, the researchers elucidated the cognitive factors contributing to difficulties in two system design elements: system design and functionality, and course content design. This approach not only provided a comprehensive understanding of the challenges but also paved the way for targeted interventions to enhance the design of the e-training system. The findings of Idris et al. (2022) underscore the importance of ACTA in informing evidence-based interventions aimed at optimizing training systems and improving learning outcomes. ACTA encompasses a range of interview methods designed to elicit detailed information about the cognitive demands and skills required for task execution. These methods include:

Task Diagram:

Task diagrams serve as visual representations of task structures, outlining the sequential steps and decision points involved in task execution. By mapping out the cognitive processes underlying task performance, task diagrams provide a holistic view of the task architecture and facilitate the identification of critical decision points and potential errors. Research by Gore, Banks and McDowall (2018) in the field of engineering utilized task diagrams to analyse the cognitive processes involved in problem-solving tasks, shedding light on the strategies employed by expert engineers to navigate complex problems efficiently. Similarly, Wahid et al. (2023) leveraged task diagrams in their investigation of knowledge task difficulties within the realm of designing a professional ethics instructional framework for technical educators. By employing task diagrams, they visually represented the intricate structures and decision points inherent in the design process. This approach allowed them to delineate the cognitive processes involved in crafting the instructional framework comprehensively. Through their analysis, Wahid et al. (2023) were able to gain insights into the challenges faced by educators and identify critical decision points where interventions could enhance the effectiveness of professional ethics instruction. Building on these applications, Alias (2025) demonstrated the utility of task diagrams in higher education by analyzing the cognitive processes underlying microlearning pedagogical practices. This study employed task diagrams to develop the AMPLIFY framework, aimed at enhancing microlearning strategies. By mapping the intricate steps in the framework's development, Alias (2025) identified critical decision points and potential barriers, offering practical insights for the systematic implementation of microlearning strategies in higher education.

Knowledge Audit:

Knowledge audits delve into the explicit and implicit knowledge required to perform a task, uncovering the cognitive resources and information processing strategies employed by individuals. Through structured interviews, knowledge audits elucidate the domain-specific knowledge structures and problem-solving heuristics that underpin task performance. In a recent study conducted by Wahid et al. (2023) in the field of education, knowledge audits were employed to explore the challenges associated with designing a professional ethics instructional framework tailored for technical educators within higher education settings. Drawing upon expert insights, several strategies were proposed for novice technical educators: i) conducting preliminary assessments of students' profiles to determine optimal delivery methods, ii) encouraging technical educators to participate in courses focused on teaching and learning theories, iii) providing training sessions on alternative pedagogical approaches, and iv) fostering an interactive teaching and learning environment where students are actively engaged in the process. These strategies offer valuable pathways for enhancing the effectiveness of professional ethics instruction among technical educators, ultimately fostering a more engaging and impactful learning experience for both educators and students alike.

Similarly, Alias (2025) employed knowledge audits to analyze the cognitive resources and strategies involved in the development of microlearning pedagogical practices within higher education. By leveraging expert insights, the study identified key challenges and strategies for designing

microlearning modules that align with the AMPLIFY framework. These strategies include developing clear objectives, integrating personalized learning pathways, and fostering interactive learning experiences. Alias (2025) demonstrated how knowledge audits can uncover critical decision points and provide actionable insights to optimize microlearning practices, bridging the gap between theory and practical implementation in higher education.

In summary, ACTA serves as a powerful tool for dissecting complex cognitive tasks and uncovering the cognitive processes underlying task performance. Recent research across various domains demonstrates the efficacy of ACTA methodologies, including task diagrams, knowledge audits, simulation interviews, and cognitive demands tables, in elucidating the cognitive intricacies of diverse tasks. By providing a systematic framework for understanding cognitive demands, ACTA informs instructional design, training interventions, and performance improvement strategies, thereby enhancing task performance and facilitating skill development across diverse domains.

The primary purpose of this study is to utilize ACTA methodologies to explore the cognitive demands involved in establishing learning objectives. Specifically, the objectives of the research are as follows: (1) to employ task diagrams and knowledge audit techniques to dissect the cognitive demands underlying the establishment of learning objectives, (2) to elicit detailed cognitive processes from experts through ACTA methodologies, and (3) and to illuminate the cognitive dimensions of establishing learning objectives and their implications for instructional design, training, and educational research.

Understanding learning objectives is crucial for designing effective educational and training programs. By leveraging ACTA, this research aims to provide valuable insights into the cognitive processes involved in establishing learning objectives. Such insights can inform instructional design practices, enhance training effectiveness, and contribute to the advancement of educational research. Moreover, in an era characterized by rapid technological advancements and evolving pedagogical approaches, the relevance of ACTA in elucidating cognitive demands cannot be overstated. By adopting a systematic and evidence-based approach, this study contributes to the growing body of literature on ACTA and its utility in understanding complex cognitive tasks such as establishing learning objectives.

2. Literature Review

2.1 Overview of Learning Objectives

Learning objectives serve as fundamental pillars within educational and training programs, offering a succinct articulation of the intended outcomes of instruction. These objectives act as navigational beacons for both learners and instructors, delineating the knowledge, skills, and competencies that learners are expected to acquire throughout the learning journey. As emphasized by Orr (2022), learning objectives play an indispensable role in guiding instructional design, assessment, and evaluation efforts, ensuring a cohesive alignment between educational activities and desired learning outcomes. By providing a clear roadmap, learning objectives not only enhance the overall effectiveness of instruction but also facilitate the measurement of learner progress and attainment of educational goals. In essence, they form the backbone of pedagogical frameworks, fostering a structured and purposeful approach to teaching and learning.

2.2 Theoretical Frameworks Related to Learning Objectives

Several theoretical frameworks underpin the conceptualization and design of learning objectives, offering valuable insights into the cognitive processes involved in learning. These frameworks not only guide instructional design but also facilitate the development of effective teaching strategies. Among the prominent theoretical frameworks related to learning objectives is the Behavioural Objectives framework, which is deeply rooted in behaviourism, alongside Cognitive Learning Theories and Taxonomies of Learning. These frameworks collectively provide comprehensive guidance for educators in designing meaningful learning experiences, understanding the cognitive processes underlying learning, and categorizing learning objectives based on cognitive complexity.

2.2.1 Behavioural Objectives

Behaviourism, pioneered by psychologists such as B.F. Skinner asserts that human behaviour is shaped by external stimuli and reinforcement (Skinner, 1938). In the context of learning objectives, the Behavioural Objectives framework emphasizes observable and measurable learning outcomes. By specifying the desired learner behaviours in terms of performance criteria, this framework enables educators to articulate clear expectations and facilitate precise assessment and evaluation.

Research supporting the efficacy of Behavioural Objectives in educational settings is abundant. For instance, an exploratory study by Osueke et al. (2018) found that learning outcomes were significantly improved when instructional objectives were clearly defined and aligned with assessment measures. Moreover, the research indicated that students commonly perceived learning objectives as beneficial, as they assisted them in narrowing their focus and structuring their learning. This highlights the practical benefits of implementing well-defined learning objectives in educational contexts. Similarly, a study by Rezki and Tatai (2019) demonstrated that students exposed to well-defined behaviours experienced a significant enhancement in their language performance. The findings revealed that educators who utilized behavioural objectives effectively structured their lessons to align with specific learning outcomes, thereby providing students with clear direction and expectations. This structured approach fostered a more focused learning environment, allowing students to better engage with the material and demonstrate improved language proficiency. Moreover, the study highlighted the importance of incorporating Robert Mager's theory of behavioural objectives into language instruction, as it facilitated a systematic and goal-oriented approach to teaching and learning. Overall, the research underscores the positive impact of implementing behavioural objectives on students' language learning outcomes.

Moreover, the Behavioural Objectives framework provides a structured approach to instructional design, guiding educators in the development of learning activities and assessments that directly align with desired outcomes. This alignment is crucial for fostering meaningful learning experiences and ensuring that learners acquire the intended knowledge and skills. The learning objectives specified within this framework follow a structured format, encompassing the learner, the behaviour, and the conditions and criteria for determining mastery (Redding, 2018). This systematic approach ensures that educators articulate clear expectations and facilitate precise assessment and evaluation. By including components such as the learner/behaviour, condition, and criteria for mastery, educators can effectively communicate the intended learning outcomes and tailor instruction to meet the diverse needs of learners.

In summary, the Behavioural Objectives framework, rooted in behaviourism, offers a systematic approach to designing learning objectives that are observable, measurable, and conducive to effective assessment. Supported by empirical research, this framework continues to inform instructional practices and contribute to the enhancement of learning outcomes in diverse educational contexts.

2.2.2 Cognitive Learning Theories

Cognitive Learning Theories, including constructivism and cognitivism, are pivotal in shaping our understanding of how learners acquire knowledge and skills (Ertmer & Newby, 2013). These theories prioritize the role of cognitive processes, such as attention, memory, and problem-solving, in the learning process. By focusing on mental activities, cognitive learning theories offer valuable insights into how learners perceive, process, and retain information.

Constructivism posits that learners actively construct their understanding of the world by integrating new knowledge with existing cognitive structures (Shah, 2019). This theory emphasizes the importance of meaningful learning experiences and the social context in which learning occurs. Recent research in constructivism has underscored the significance of integrating constructivist principles into teaching practices, aiming to create effective learning environments for all students. By incorporating these principles, educators can enhance meaningful learning and critical thinking skills, ultimately leading to improvements in academic standards and student performance (Zajda, 2021). Additionally, Bharathi and Pande (2024) found that constructivist principles, such as maximizing existing knowledge, experiential learning, and adaptive cognition, play a significant role in fostering creative thinking skills. Their study highlights the importance of these constructivist principles in promoting the development

of creative thinking abilities, particularly in the transition from online to hybrid learning environments in the post-pandemic era.

Cognitivism, on the other hand, emphasizes the internal mental processes involved in learning, such as attention, memory, and problem-solving (Clark, 2018). This theory suggests that learning is an active process of mental restructuring, where learners organize information into meaningful schemas and apply cognitive strategies to solve problems. Recent studies in cognitive psychology have elucidated the role of metacognitive processes, such as self-regulation and reflection, in enhancing learning outcomes (Khiat & Vogel, 2022). Self-regulated learning theory suggests that teachers can leverage metacognitive elements to improve students' cognitive abilities and enhance pedagogical knowledge and teaching efficiency (Hamzah, Hamzah & Zulkifli, 2023). By incorporating this theory into teaching and learning practices, educators can effectively cultivate students' thinking skills based on metacognition. This underscores the importance of integrating metacognitive strategies into instructional design to support students' overall learning and development.

Research supporting cognitive learning theories underscores their practical implications for instructional design and pedagogy. For example, Wilson (2020) found that instructional strategies based on cognitive learning theories, such as inquiry-based instruction, were associated with higher student achievement. Similarly, Dorji (2021) found that cognitive learning theories such as problem-based learning increase students' achievement. Similarly, a study by Tsiriotakis et al. (2021) demonstrated the effectiveness of cognitive apprenticeship models in fostering deep conceptual understanding and transferable skills. The findings indicate that the cognitive apprenticeship model facilitated improvements in the students' writing abilities, leading to stronger, higher quality, and longer argumentative essays. These findings highlight the effectiveness of cognitive learning theories in guiding instructional practices and improving learning outcomes across diverse educational settings.

In summary, cognitive learning theories provide a robust framework for understanding the cognitive processes involved in learning and inform the development of effective instructional strategies. Supported by recent research, these theories continue to shape educational practices and contribute to the enhancement of learning outcomes across diverse learning contexts.

2.2.3 Taxonomies of Learning

Taxonomies of Learning, exemplified by Bloom's taxonomy and Anderson and Krathwohl's revised taxonomy, are foundational tools in educational planning and assessment. These taxonomies offer hierarchical frameworks for categorizing learning objectives based on cognitive complexity, allowing educators to design instruction that addresses diverse cognitive levels and fosters deeper understanding.

Bloom's taxonomy, initially developed in the 1950s and revised in the 2000s, outlines a hierarchy of cognitive processes ranging from simple to complex. The taxonomy includes six levels: Remembering, Understanding, Applying, Analysing, Evaluating, and Creating (Krathwohl, 2002; Anderson & Krathwohl, 2001). Each level represents increasingly sophisticated cognitive tasks, from basic recall of information to the synthesis of new ideas. Recent research has underscored the enduring relevance of Bloom's taxonomy in instructional design, with studies demonstrating its utility in promoting critical thinking and problem-solving skills across various educational contexts. For instance, Niazi and Lodhi (2021) concluded that incorporating Bloom's objectives of teaching would be able to improve English language learning among students at the tertiary level. Additionally, Nurmatova and Altun (2023) found in their review analysis that using Bloom's Taxonomy provides EFL teachers with a guide and diverse set of tools to support the development of language skills and cognitive abilities suitable for all types of learners. Overall, these findings highlight the importance of integrating Bloom's taxonomy into educational practices to enhance learning outcomes and foster the growth of students' cognitive abilities

In summary, taxonomies of learning provide essential frameworks for categorizing learning objectives and guiding instructional design. Supported by recent research, these taxonomies continue to inform pedagogical practices and contribute to the development of students' cognitive skills and abilities across diverse educational settings.

3. Research Methodology

This study utilized Applied Cognitive Task Analysis (ACTA) to dissect the intricate cognitive demands and skills involved in establishing learning objectives. The methodology comprises two key ACTA techniques: task diagrams and knowledge audit. Task diagrams are developed to illustrate procedural steps, while knowledge audits assess existing skills. ACTA suggests that conducting ACTA methods requires interviewing three to five experts (Militello et al., 1997). For this study, five experts in higher education were selected. All participants had more than 15 years of experience in higher education, with roles in curriculum design, instructional planning, and assessment strategies. The group represented diverse expertise, including education theory, instructional design, and curriculum and instruction, ensuring a comprehensive understanding of learning objectives. The participants held senior academic positions, such as deputy dean, department heads, and curriculum committee members, contributing to their familiarity with aligning learning objectives to institutional and accreditation standards. Additionally, the experts had authored high-impact research articles and contributed to policy documents related to curriculum development and instructional design. They also represented a mix of public and private higher education institutions, providing a well-rounded perspective on curriculum and instruction across varied educational contexts. The group comprised four male and one female participant. By including participants with extensive and diverse expertise, this study ensured the reliability and applicability of the findings to broader educational contexts.

Data collection involved the administration of ACTA methodologies, including task diagrams and knowledge audits. Data collection was conducted over a eight-week period and involved the structured administration of ACTA methodologies, specifically Task Diagram and Knowledge Audit techniques. Interviews were scheduled based on participants' availability to allow for comprehensive discussions, and all participants were briefed on the study's objectives and procedures prior to the sessions. Informed consent was obtained from each participant. Task diagram interviews were conducted, focusing on deconstructing the process of establishing learning objectives into smaller subtasks, as guided by the Task Diagram prompts. These interviews lasted approximately 60–90 minutes, with audio recordings and notes taken for subsequent analysis. Following this, Knowledge Audit sessions were conducted with the same participants to delve deeper into the cognitive strategies, cues, and challenges associated with establishing learning objectives. These interviews also lasted 60–90 minutes and were similarly recorded for transcription and analysis. All interviews were transcribed verbatim and coded using thematic analysis techniques. Findings from both Task Diagram and Knowledge Audit sessions were synthesized to develop a comprehensive understanding of the cognitive processes involved in establishing learning objectives. This structured approach to data collection ensures transparency and facilitates replicability in future studies.

3.1 Task Diagram

The first phase of Applied Cognitive Task Analysis (ACTA), the task diagram technique, was utilized to identify and elicit a comprehensive list of cognitive abilities necessary for establishing learning objectives. Through interviews with subject matter experts, cognitive and non-cognitive skills essential for learning objectives were distinguished. Task diagram interviews were conducted to deconstruct the process of establishing learning objectives into smaller subtasks, aiming to identify between three to six relevant subtasks. The interview questions were formulated based on sample questions presented by Militello et al. (1997). These questions served as a valuable reference to ensure the thoroughness and effectiveness of the interview process. By utilizing established sample questions, the interview can gather insightful information and insights from the experts regarding the subtasks and their relationship to the overall tasks.

Task Diagram Prompts:
(*Used to deconstruct the process of establishing learning objectives into key procedural steps.*)

1. What are the main steps you follow when establishing learning objectives in a course or training program?
2. Can you break down the process into smaller tasks? How do these tasks connect to one another?
3. Are there any critical decisions you make at each stage of the process? What factors influence these decisions?
4. Are there points in the process where things could go wrong? What potential errors or challenges might arise?
5. Can you provide an example of a time when defining learning objectives was particularly challenging? How did you address it?
6. If you had to explain this process to a new educator, how would you structure it? What are the most important elements to emphasize?
7. Which aspects of this process require the most cognitive effort or expert judgment?
8. What tools or resources do you rely on when developing learning objectives?
9. How do you determine whether a learning objective is well-defined and effective?

3.2 Knowledge Audit

The second phase of ACTA, the knowledge audit method, involved using a series of questions to elicit examples suitable for describing various types of domain knowledge or abilities. In-depth interviews were conducted to explore cognitive task challenges identified through the task diagram technique. Insights into cues, strategies, and management of difficulties in establishing learning objectives, as well as underlying causes of these challenges, were sought through the knowledge audit. To guide the interviews and ensure a thorough exploration of the issues, a set of prompts was employed. These prompts, adapted from the inquiries proposed by Militello et al. (1997), are recognized for their effectiveness in extracting valuable insights in comparable contexts. Utilizing these prompts enables a systematic collection of detailed responses during the interviews, illuminating the experiences and expertise of the participants. The knowledge audit interviews aimed to provide a comprehensive understanding of the cognitive challenges inherent in the tasks, as well as the associated cues, strategies, and management approaches utilized by experts. Through the identification of these challenges' root causes, targeted interventions and solutions were developed to establish learning objectives.

Knowledge Audit Prompts:
(*Used to elicit deeper cognitive strategies, cues, and expertise in setting learning objectives.*)

1. What are the most critical knowledge and skills required to effectively establish learning objectives?
2. What cues do you rely on to determine whether a learning objective is appropriate or needs revision?
3. Can you describe a situation where you had to modify a learning objective? What prompted the change?
4. How do you distinguish between an effective and an ineffective learning objective?
5. What types of decisions do you have to make when aligning learning objectives with curriculum standards?
6. What strategies do you use when encountering difficulties in defining or refining learning objectives?
7. Can you recall a case where a misalignment between learning objectives and assessments impacted learning outcomes? How did you address it?
8. What information or data sources do you use when defining learning objectives?
9. What do novice educators often struggle with when crafting learning objectives, and what advice would you give them?
10. How do you adjust learning objectives based on feedback from students, colleagues, or assessments?

4. Findings

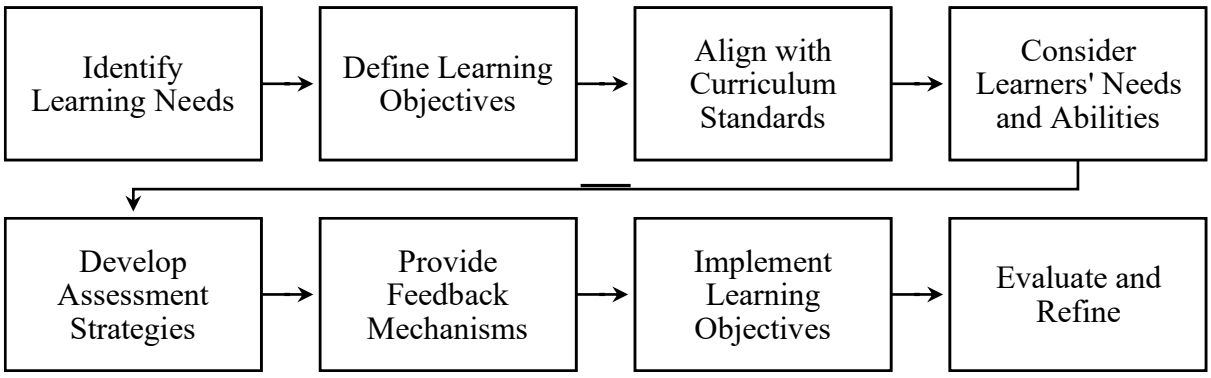
The findings of the study are presented in two distinct sections: task diagram and knowledge audit. Each section offers a detailed analysis of the data collected through the respective method, providing valuable insights into the cognitive processes underlying the establishment of learning objectives. The task diagram section elucidates the procedural steps involved in designing and developing learning objectives, while the knowledge audit section delves into the existing skills and cognitive challenges identified by experts. Together, these sections provide a comprehensive analysis of the research outcomes and their implications for instructional design and educational practice as presented in the following section 4.1.

4.1 Task Diagram

The initial phase of the ACTA, known as the Task Diagram, aims to thoroughly identify and delineate the essential steps in establishing learning objectives. This phase entails demonstrating the sequence and interdependencies of these steps, offering a clear overview of the learning objectives process as a whole. By doing so, it enables the identification of the fundamental components necessary for effective instructional design and curriculum development. Based on the task diagram, the analysis reveals eight fundamental themes that provide a vital overview of learning objectives and its essential components. These components play a crucial role in ensuring the successful implementation of learning objectives, including clear articulation of objectives, alignment with curriculum standards, consideration of learners' needs and abilities, incorporation of assessment strategies, and provision of feedback mechanisms. Additionally, the task diagram highlights the iterative nature of the process, emphasizing the importance of ongoing evaluation and refinement to optimize learning outcomes. Figure 4.1 below illustrates the task diagram of the process of establishing learning objectives.

Figure 4.1

Task Diagram of the Process of Establishing Learning Objectives



4.2 Knowledge Audit

During the knowledge audit table technique interviews, experts shared insights into the cues and strategies they rely on when faced with difficulties in establishing learning objectives. Cues are indicators or prompts guiding the design and implementation of cognitive tasks related to establishing learning objectives, while strategies are deliberate approaches employed to integrate cognitive tasks effectively. The steps identified through the Task Diagram process, such as Identifying Learning Needs and Defining Learning Objectives, served as the basis for the Knowledge Audit phase. Detailed examples of cues, strategies, and challenges associated with these steps are provided in the Knowledge Audit Table (Table 4.1). Building upon the previously explained task diagram, the cognitive skills identified by experts were further examined. In Table 4.1, the knowledge audit table encompasses the cues and strategies recognized by experts as essential cognitive elements within the process of

establishing learning objectives. This table serves as a valuable resource, providing educators with insights into effective approaches and techniques for overcoming cognitive challenges in instructional design and curriculum development.

Table 4.1

Knowledge Audit Table

No.	Critical Cognitive Components of Establishing Learning Objectives	Cues and Strategies	Why Difficult?
1.	Identifying students' learning needs	Cues: 1. Varied performance levels among students in the classroom. 2. Lack of engagement or participation in certain subjects or activities. 3. Student inquiries or questions indicating confusion or gaps in understanding. 4. Observations of student behaviour, such as disinterest or frustration during lessons. 5. Discrepancies between students' stated interests and their demonstrated abilities. Strategies: 1. Conducting diagnostic assessments to identify students' strengths and weaknesses. 2. Using informal methods such as classroom observations and student interviews to gather insights. 3. Reviewing past academic records and performance data to identify trends. 4. Collaborating with colleagues or specialists to gain additional perspectives. 5. Providing opportunities for student self-assessment and reflection.	1. Students may have varying learning styles or preferences, making it challenging to address everyone's needs effectively. 2. Limited resources or support services may constrain the ability to provide personalized assistance. 3. Time constraints within the curriculum may make it difficult to dedicate sufficient attention to individual student needs. 4. Language barriers or cultural differences may hinder communication and understanding. 5. Some students may have unidentified learning disabilities or other underlying factors impacting their learning process.
2.	Defining learning objectives	Cues: 1. Discrepancies between stated curriculum standards and students' current knowledge or skills.	1. Balancing the need for specificity with the flexibility to accommodate diverse learners and instructional contexts.

No.	Critical Cognitive Components of Establishing Learning Objectives	Cues and Strategies	Why Difficult?
		2. Feedback from previous assessments indicating areas of weakness or misunderstanding. 3. Observations of student engagement levels and participation during lessons. 4. Input from colleagues, administrators, or external stakeholders regarding educational priorities or goals. 5. Changes in student demographics, needs, or interests over time. Strategies: 1. Reviewing curriculum frameworks, standards, and guidelines to ensure alignment. 2. Conducting needs assessments or surveys to gather input from students, parents, and other stakeholders. 3. Collaborating with colleagues to identify common learning goals and objectives across grade levels or subject areas. 4. Incorporating principles of backward design to align learning objectives with desired outcomes and assessments. 5. Using SMART criteria (Specific, Measurable, Achievable, Relevant, Time-bound) to ensure clarity and effectiveness in defining objectives.	2. Ensuring that learning objectives are both rigorous and attainable within the constraints of available resources and instructional time. 3. Addressing the potential for ambiguity or misunderstanding among stakeholders regarding the purpose and scope of learning objectives. 4. Accounting for the dynamic nature of educational environments and the evolving needs of students and communities. 5. Navigating competing priorities and demands within the curriculum, school, or district, which may influence the selection and prioritization of learning objectives.
3.	Aligning learning objectives with curriculum standards	Cues: 1. Discrepancies between stated curriculum standards and current learning objectives. 2. Feedback from curriculum specialists or administrators regarding alignment issues. 3. Analysis of student performance data revealing gaps in alignment with curriculum standards. 4. Comparison of learning objectives to specific standards or competencies outlined in curriculum documents.	1. Curriculum standards may be complex or extensive, requiring careful analysis and interpretation to ensure alignment with learning objectives. 2. Changes in curriculum standards or educational policies may necessitate ongoing adjustments to learning objectives and instructional practices. 3. Balancing the need for alignment with

No.	Critical Cognitive Components of Establishing Learning Objectives	Cues and Strategies	Why Difficult?
		5. Observations of instructional materials, assessments, and activities to assess alignment with curriculum standards. Strategies: 1. Mapping learning objectives to specific standards or competencies outlined in the curriculum documents to ensure alignment. 2. Revising or refining learning objectives to better reflect the scope and depth of content covered in the curriculum standards. 3. Integrating interdisciplinary connections and real-world applications to enhance the relevance and authenticity of learning objectives. 4. Providing professional development opportunities for educators to deepen their understanding of curriculum standards and effective alignment strategies. 5. Collaborating with colleagues to share resources, ideas, and best practices for aligning learning objectives with curriculum standards.	curriculum standards while maintaining flexibility to address diverse student needs and interests. 4. Limited resources or instructional time may constrain the ability to fully align learning objectives with curriculum standards. 5. Ensuring that learning objectives are both rigorous and attainable within the constraints of available resources and instructional time.
4.	Considering learners' needs and abilities	Cues: 1. Variability in student performance levels within the classroom. 2. Observations of student engagement, participation, and behaviour during lessons. 3. Feedback from students regarding their interests, preferences, and learning styles. 4. Analysis of student performance data, including assessments and progress reports. 5. Input from parents, guardians, or other stakeholders regarding students' individual needs and abilities.	1. Balancing the diverse needs and abilities of students within a single classroom can be challenging. 2. Limited resources or support services may constrain the ability to provide individualized instruction. 3. Addressing individualized needs while maintaining coherence and consistency in instruction. 4. Adapting instructional materials and activities to

No.	Critical Cognitive Components of Establishing Learning Objectives	Cues and Strategies	Why Difficult?
		Strategies: 1. Conducting needs assessments or surveys to gather information about students' interests, preferences, and learning styles. 2. Providing differentiated instruction to accommodate diverse learners and address individual needs. 3. Offering flexible grouping arrangements to facilitate peer collaboration and support. 4. Implementing Universal Design for Learning (UDL) principles to create inclusive and accessible learning environments. 5. Providing opportunities for student self-assessment and reflection to promote metacognitive awareness.	meet the needs of students with varying abilities and learning styles. 5. Ensuring equitable access to educational opportunities for all students, regardless of their individual needs and abilities.
5.	Developing assessment strategies	Cues: 1. Variability in student performance levels observed during classroom activities and assignments. 2. Feedback from students indicating areas of strength and weakness in their understanding of course material. 3. Analysis of student performance on formative assessments, quizzes, or homework assignments. 4. Review of curriculum standards or learning objectives to identify specific knowledge and skills to be assessed. 5. Input from colleagues, curriculum specialists, or assessment experts regarding effective assessment practices. Strategies: 1. Aligning assessment strategies with learning objectives and curriculum standards to ensure validity and reliability.	1. Ensuring that assessment strategies accurately measure desired learning outcomes while minimizing bias or subjectivity. 2. Balancing the need for summative assessments to evaluate student achievement with formative assessments to support learning. 3. Addressing logistical challenges such as time constraints, resource limitations, and administrative requirements. 4. Adapting assessment strategies to accommodate diverse learners with varying abilities, backgrounds, and learning styles. 5. Ensuring that assessment practices are fair, equitable, and accessible

No.	Critical Cognitive Components of Establishing Learning Objectives	Cues and Strategies	Why Difficult?
		2. Using a variety of assessment formats, such as written tests, oral presentations, projects, or performance tasks, to accommodate diverse learners. 3. Incorporating formative assessments throughout instruction to monitor student progress and provide timely feedback. 4. Providing rubrics or scoring guides to clarify expectations and criteria for assessment. 5. Offering opportunities for student self-assessment and reflection to promote metacognitive awareness and ownership of learning.	to all students, regardless of their individual needs or circumstances.
6.	Providing feedback mechanisms	Cues: 1. Observations of student performance during classroom activities, discussions, or presentations. 2. Analysis of student work, including assignments, projects, and assessments. 3. Feedback from students, either solicited through surveys or provided voluntarily during class discussions. 4. Peer assessments or reviews conducted by students to provide feedback to their peers. 5. Input from colleagues or administrators regarding effective feedback practices. Strategies: 1. Offering timely and specific feedback that is focused on student performance relative to learning objectives or criteria. 2. Using a variety of feedback formats, such as written comments, oral feedback, rubrics, or self-assessment tools. 3. Providing opportunities for students to revise or improve their work based on feedback received.	1. Balancing the need for feedback that is both constructive and supportive with the desire to motivate and engage students. 2. Addressing logistical challenges such as time constraints, workload, and competing priorities. 3. Providing feedback that is individualized and personalized to meet the diverse needs and abilities of students. 4. Ensuring that feedback is actionable and meaningful, providing students with clear guidance on how to improve their performance. 5. Fostering a culture of feedback that values continuous improvement and encourages students to actively engage with feedback to enhance their learning.

No.	Critical Cognitive Components of Establishing Learning Objectives	Cues and Strategies	Why Difficult?
		4. Incorporating peer feedback and peer review activities to promote collaboration and peer learning. 5. Establishing clear expectations and criteria for feedback to ensure consistency and fairness.	
7.	Implementing objectives	Cues: 1. Observations of student engagement, participation, and understanding during lessons. 2. Analysis of student work and performance on assessments related to the objectives. 3. Feedback from students regarding their experiences with the instructional activities and materials. 4. Reflection on the effectiveness of instructional strategies and resources used to support the objectives. 5. Input from colleagues or administrators regarding the alignment and implementation of objectives. Strategies: 1. Designing lesson plans and activities that explicitly address the objectives and provide opportunities for active student engagement. 2. Differentiating instruction to meet the diverse needs and abilities of students while still working toward the objectives. 3. Incorporating formative assessment strategies to monitor student progress and adjust instruction as needed. 4. Providing scaffolding and support to help students achieve the objectives, such as modeling, guided practice, and feedback. 5. Collaborating with colleagues to share resources, ideas, and best practices for implementing objectives effectively.	1. Balancing the need for rigorous and challenging objectives with the need to ensure that they are attainable for all students. 2. Addressing logistical challenges such as time constraints, resource limitations, and classroom management issues. 3. Responding to unexpected events or disruptions that may impact the implementation of objectives. 4. Ensuring that instructional materials and activities are aligned with the objectives and support student learning. 5. Fostering a supportive and inclusive learning environment where all students feel motivated and empowered to work toward the objectives.

No.	Critical Cognitive Components of Establishing Learning Objectives	Cues and Strategies	Why Difficult?
8.	Evaluating and refining the process iteratively	Cues: 1. Analysis of student performance data, including assessment results and progress towards learning objectives. 2. Feedback from students, parents, colleagues, or administrators regarding the effectiveness of instructional practices. 3. Observations of classroom instruction, student engagement, and participation. 4. Reflection on the outcomes of instructional decisions and their impact on student learning. 5. Comparison of current practices to research-based best practices and educational standards. Strategies: 1. Using formative assessment data to inform instructional decisions and adjust teaching strategies as needed. 2. Seeking input from colleagues through professional learning communities or collaborative planning meetings. 3. Conducting action research or case studies to systematically investigate the effectiveness of instructional practices. 4. Implementing a cycle of continuous improvement, where feedback is collected, analysed, and used to make informed changes. 5. Engaging in ongoing professional development to stay informed about current research and best practices in education.	1. Balancing the need for continuous improvement with the demands of daily instruction and administrative responsibilities. 2. Addressing resistance to change among stakeholders who may be accustomed to traditional practices. 3. Ensuring that evaluation processes are fair, transparent, and evidence-based. 4. Identifying and prioritizing areas for improvement based on available data and resources. 5. Sustaining momentum for improvement efforts over time, especially in the face of competing priorities and external pressures.

5. Discussion

The findings from the task diagram and knowledge audit shed light on the intricate cognitive demands and skills involved in establishing learning objectives. The task diagram provided a comprehensive overview of the procedural steps necessary for this process, highlighting key components such as identifying learning needs, defining objectives, aligning with curriculum standards, considering learners' needs and abilities, developing assessment strategies, providing feedback mechanisms, implementing objectives, and evaluating and refining the process iteratively.

One of the key themes identified through the task diagram was the importance of aligning learning objectives with curriculum standards. This alignment ensures that instructional goals are coherent, relevant, and consistent with established educational benchmarks. By mapping learning objectives to specific standards or competencies outlined in curriculum documents, educators can ensure that their instructional practices are aligned with broader educational goals and objectives. Research by Crouch and DeStefano (2017) underscores the significance of coherence in instructional components, showing that interventions focusing on tightly aligned pedagogical practices can lead to substantial improvements in student learning. For example, programs like Tusome in Kenya, which incorporate a coherent package of instructional materials, teacher training, and student resources calibrated to learners' levels, have achieved significant effect sizes in enhancing learning outcomes (Freudenberger and Davis, 2017; Piper et al., 2018). Similarly, the findings of Meng (2023) underscores how aligning instructional practices with education quality standards can cultivate positive learning environments and enhance student achievement. This highlights the importance of aligning not only learning objectives but also formal curriculum standards and teacher instruction to promote student learning.

The knowledge audit further elucidated the cognitive demands associated with establishing learning objectives, focusing on cues and strategies employed by educators to navigate this complex process. Educators rely on a variety of cues, such as discrepancies between stated curriculum standards and current learning objectives, feedback from students and colleagues, and observations of student performance, to inform their decision-making process. Strategies for addressing these cues include conducting needs assessments, revising learning objectives, integrating interdisciplinary connections, and providing differentiated instruction.

However, the knowledge audit also revealed several challenges inherent in this process. Aligning with curriculum standards presents a complex task, as highlighted by the findings of Zhao, Zhao, and Li (2023) in their multi-case study examining the effectiveness of aligning teaching, learning, and assessment in classroom project-based learning. Their findings highlighted that the lack of alignment among instructional elements and curriculum standards is primarily attributed to teachers' limited engineering knowledge and the unique characteristics of project-based learning in classrooms. These insights underscore the need for targeted teacher training and instructional support to address these challenges and enhance the alignment between project-based learning and curriculum standards. Additionally, balancing the diverse needs and abilities of students while maintaining alignment with curriculum standards can be challenging. Limited resources, time constraints, and competing priorities may further complicate efforts to establish effective learning objectives. Assey and Babyegeya (2022) highlighted that inadequate teaching and learning environments, challenges with instructional mediums, limited parental engagement, teacher shortages, deficient managerial skills among school leaders, and a lack of in-service training for teachers are the primary obstacles to effective teaching, learning, and assessment. Additionally, addressing individualized needs while maintaining coherence and consistency in instruction requires careful planning and coordination (UNESCO, 2023).

Despite these challenges, the findings underscore the importance of employing systematic approaches, such as the task diagram and knowledge audit, to inform instructional decision-making and promote student learning. By leveraging insights from cognitive task analysis, educators can develop more targeted and effective instructional practices, ultimately enhancing the quality of education for all students.

6. Conclusion

This study has demonstrated the effectiveness of Applied Cognitive Task Analysis (ACTA) in deconstructing and understanding the complex process of establishing learning objectives. By employing techniques such as the task diagram and knowledge audit, we uncovered not only the sequential procedural steps involved but also the deeper cognitive strategies that educators utilize to align learning objectives with curriculum standards. This alignment is crucial for ensuring that instructional goals are coherent, relevant, and effectively integrated into the broader educational framework.

The task diagram methodically revealed each stage in the establishment of learning objectives, highlighting critical junctures where decisions must be aligned with curricular benchmarks and learner needs. Meanwhile, the knowledge audit illuminated the cognitive demands placed on educators, revealing the nuanced cues and strategic decision-making processes that underpin effective instructional design. These insights emphasize the value of a systematic approach in navigating the inherent challenges of balancing diverse student needs, limited resources, and evolving curricular demands.

Our findings have significant implications for both educational practice and research. For practitioners, the study offers a structured framework that can be directly applied to enhance instructional design and assessment practices, thereby promoting improved student learning outcomes. For researchers, the application of ACTA in this context opens new avenues for exploring the intersection of cognitive processes and pedagogical strategies, suggesting that further investigation into this area could yield innovative methods for refining educational practices.

Future research should build on these findings by integrating advancements in cognitive science and educational technology to further refine instructional design models. Moreover, sustained professional development and collaboration among educators are imperative for fostering continuous improvement in instructional practices. Through these efforts, we can work toward an educational environment that is not only responsive to the cognitive demands of teaching but also proactive in advancing the quality of education for all learners.

In summary, this study not only advances our understanding of the cognitive dimensions involved in establishing learning objectives but also provides a compelling argument for the adoption of systematic, evidence-based approaches in instructional decision-making. By doing so, it lays a robust foundation for future innovations in educational practice and policy, ultimately contributing to enhanced student success in a rapidly evolving educational landscape.

7. Co-Author Contribution

The authors declare that there is no conflict of interest in this article. All authors contributed significantly to the study's conception and design. The first author conducted the literature review, data collection, and analysis, and drafted the initial manuscript. The second author played a crucial role in critically revising the manuscript to ensure its clarity and completeness. Both authors reviewed and approved the final version of the manuscript.

8. Acknowledgement

The authors wish to acknowledge that this study was conducted without any financial support. Nonetheless, we extend our sincere appreciation to all the participants who contributed their insights and experiences to this research. Special thanks are also due to the Faculty of Education, UiTM, for providing continuous support throughout the study.

9. References

Alias, N. F. (2025). Pedagogical Practices of Microlearning Educational Experience: A Design-Based Research. In R. Razak, N. Alias, & A. Idris (Eds.), *Multidisciplinary Educational Perspectives on Design-Based Research* (pp. 239-308). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-8452-7.ch007

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives: Complete edition.* New York: Longman.

Arulsamy, A. S., Singh, I., Kumar, M. S., Panchal, J. J., & Bajaj, K. K. (2023). Employee training and development enhancing employee performance – A study. *Samdarshi*, *16*(3), 406.

Assey, E. S., & Babyegeya, E. (2022). The challenges facing effective teaching, learning and assessment in community-based secondary schools in Tabora Region. *American Journal of Education and Practice*, *6*(2), 1-17. https://doi.org/10.47672/ajep.1084

Bharathi, S. V., & Pande, M. B. (2024). Does constructivism learning approach lead to developing creative thinking skills? The mediating role of online collaborative learning environments. *Journal of Computer Assisted Learning. Advance online publication*. https://doi.org/10.1007/s40692-024-00321-2

Clark, K. R. (2018). Learning Theories: Cognitivism. *Radiologic Technology*, 90(2), 176-179

Crouch, L., & DeStefano, J. (2017). *Doing reform differently: Combining rigor and practicality in implementation and evaluation of system reforms* (International Development Working Paper, No. 2017-01). Research Triangle Park, NC: RTI International.

Dorji, T. (May 2021). Effect of using problem-based learning on the academic achievement of higher secondary school students. *International Journal of Asian Education*, *2*(2), 235-243. https://doi.org/10.46966/ijae.v2i2.120

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, *26*(2), 43-71.

Freudenberger, E., & Davis, J. (2017). *Tusome external evaluation—Midline report*. Prepared for the Ministry of Education of Kenya, USAID/Kenya, and the UK DFID under contract no. AID-615-TO-16–00012. MSI, a Tetra Tech company, Washington, DC.

Gore, J., Banks, A.P. & McDowall, A. (2018). Developing cognitive task analysis and the importance of socio-cognitive competence/insight for professional practice. *Cognition, Technology and Work, 20,* 555–563. https://doi.org/10.1007/s10111-018-0502-2

Graham, L. A., Gray, C., Wagner, T. H., Illarmo, S., Hawn, M. T., Wren, S. M., Iannuzzi, J., & Harris, A. H. S. (2023). Applying cognitive task analysis to health services research. *Health Services Research*, *58*(2), 415–422. https://doi.org/10.1111/1475-6773.14106

Gray, J. A., & DiLoreto, M. (2016). The effects of student engagement, student satisfaction, and perceived learning in online learning environments. *International Journal of Educational Leadership Preparation*, 11, (1).

Hamzah, H., Hamzah, M. I., & Zulkifli, H. (2023). Self-regulated learning theory in metacognitive-based teaching and learning of high-order thinking skills (HOTS). *TEM Journal*, *12*(4), 2530-2540. https://doi.org/10.18421/TEM124-65

Idris, A. Y., Razak, R. A. & Rahman, S. S. A. (2022). Investigating knowledge task difficulties in an e-training system for professional development design. *Docens Series in Education*, *2*, 51-65.

Khiat, H., & Vogel, S. (2022). A self-regulated learning management system: Enhancing performance, motivation and reflection in learning. *Journal of University Teaching & Learning Practice*, 19(2), 43-59. https://doi.org/10.53761/1.19.2.4

Knisely, B. M., Joyner, J. S., & Vaughn-Cooke, M. (2021). Cognitive task analysis and workload classification. *MethodsX, 8,* 101235. https://doi.org/10.1016/j.mex.2021.101235

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory Into Practice*, *41*(4), 212–218. https://doi.org/10.1207/s15430421tip4104_2

Meng, S. (2023). Enhancing teaching and learning: Aligning instructional practices with education quality standards. *Research and Advances in Education*, *2*(7), 17. https://doi.org/10.56397/RAE.2023.07.04

Militello, L. G., & Hutton, R. J. B. (1998). Applied cognitive task analysis (ACTA): A practitioner's toolkit for understanding cognitive task demands. *Ergonomics*, *41*(11), 1618–1641. https://doi.org/10.1080/001401398186108

Niazi, S., & Lodhi, F. A. (2021). A critical study about the effects of Bloom's taxonomy in

the context of English language teaching at university level. *The Journal of Educational Research*, *4*(2), 87. https://doi.org/10.52337/pjer.v4i2.178

Nurmatova, S., & Altun, M. (2023). A comprehensive review of Bloom's taxonomy integration to enhancing novice EFL educators' pedagogical impact. *Arab World English Journal*, *14*(3), 380-388. https://doi.org/10.24093/awej/vol14no3.24

Orr, R. B., Csikari, M. M., Freeman, S., & Rodriguez, M. C. (2022). Writing and using learning objectives. *CBE—Life Sciences Education*, *21*(3), fe3. https://doi.org/10.1187/cbe.22-04-0073.

Osueke, B., Mekonnen, B., & Stanton, J. D. (2018). How undergraduate science students use learning objectives to study. *Journal of microbiology & biology education*, *19*(2), 19.2.69. https://doi.org/10.1128/jmbe.v19i2.1510

Papautsky, E. L., Strouse, R., & Dominguez, C. (2020). Combining cognitive task analysis and participatory design methods to elicit and represent task flows. *Journal of Cognitive Engineering and Decision Making*, *14*(4), 288-301. https://doi.org/10.1177/1555343420976014

Piper, B., DeStefano, J., Kinyanjui, E. M., et al. (2018). Scaling up successfully: Lessons from Kenya's Tusome national literacy program. *Journal of Educational Change*, *19*(3), 293–321. https://doi.org/10.1007/s10833-018-9325-4

Redding, S. (2018). *Instructional Design*. Center on Innovation in Learning (CIL). Retrieved from https://files.eric.ed.gov/fulltext/ED607628.pdf

Rezki, A., & Tatai, O. (2019). *Teaching through Behavioral Objectives to Enhance EFL Learning: An Investigation of Second Year Teachers' Attitudes and Practices in the Department of English at Mouloud Mammeri University of Tizi-Ouzou* [Master's thesis, Mouloud Mammeri University of Tizi-Ouzou].

Russ-Jara, A. L., Elkhadragy, N., Arthur, K. J., DiIulio, J. B., Militello, L. G., Ifeachor, A. P., Glassman, P. A., Zillich, A. J., & Weiner, M. (2023). Cognitive task analysis of clinicians' drug–drug interaction management during patient care and implications for alert design. *BMJ Open*, *13*, e075512. https://doi.org/10.1136/bmjopen-2023-075512

Seamster, T. L., & Redding, R. E. (2017). *Applied Cognitive Task Analysis in Aviation*. London: Routledge. https://doi.org/10.4324/9781315262321

Sewagegn, A. A. (2020). Learning objective and assessment linkage: Its contribution to meaningful student learning. *Universal Journal of Educational Research*, *8*(11), 5044–5052123. https://doi.org/10.13189/ujer.2020.081104.

Shah, R. K. (2019). Effective constructivist teaching learning in the classroom. *Shanlax International Journal of Education*, *7*(4), 1–13. https://doi.org/10.34293/education.v7i4.600

Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis.* New York, NY: Appleton-Century

Solari, M., Vizquerra, M. I., & Engel, A. (2022). Students' interests for personalized learning: An analysis guide. *European Journal of Psychology of Education*, *38*, 1073–1109. https://doi.org/10.1007/s10212-022-00656-3

Swaby, L., Shu, P., Hind, D., & Sutherland, K. (2022). The use of cognitive task analysis in clinical and health services research — a systematic review. *Pilot and Feasibility Studies*, *8*(1), 57. https://doi.org/10.1186/s40814-022-01002-6

Tsiriotakis, I. K., Spiliotopoulos, V., Grünke, M., & Kokolakis, K. (2021). The effects of a cognitive apprenticeship model on the argumentative texts of EFL learners. *Journal of Education and Learning*, *10*(5), 63-75. https://doi.org/10.5539/jel.v10n5p63

UNESCO Office Bangkok and Regional Bureau for Education in Asia and the Pacific. (2023). *Addressing learning needs in the Asia-Pacific region: teachers' guide on diagnostic assessment*

Wahid, S. A., N., Razak, R. A., & Halili, S. H. (2023). Investigating knowledge task difficulties in designing professional ethics instructional framework for technical educators. *Jurnal Penyelidikan Pendidikan*, *41*(1), 45-57.

Wilson, C. E. (2020, October 23). *The Effects of Inquiry-Based Learning and Student Achievement in the Science Classroom*. Eagle Scholar: Student Research Submissions. University of Mary Washington. Retrieved from https://scholar.umw.edu/student_research/370

Zajda, J. (2021). Constructivist learning theory and creating effective learning environments. In: *Globalisation and Education Reforms.* Globalisation, Comparative Education and Policy Research, vol 25. Springer, Cham. https://doi.org/10.1007/978-3-030-71575-5_3

Zhao, L., Zhao, B., & Li, C. (2023). Alignment analysis of teaching–learning-assessment within the classroom: how teachers implement project-based learning under the curriculum standards. *Disciplinary and Interdisciplinary Science Education Research*, *5*, 13. https://doi.org/10.1186/s43031-023-00078-1