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Objectives and Content Required for Developing a Thinking-Based Learning Module in Fabrication and Welding Trade in Technical Colleges in North-Central Nigeria

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ABSTRACT*: This study determined the objectives and content required for developing a Thinking-Based Learning (TBL) module in fabrication and welding tradein technical colleges in North-Central Nigeria. The study was motivated by the need to integrate higher-order thinking skills with practical and technical competencies in fabrication and welding trade instruction. A Research and Development (R&D) design was adopted for the study. Two objectives, two research questions, and two corresponding null hypotheses guided the study. The population comprised 52 respondents, consisting of 31 fabrication and welding trade teachers in technical colleges and 21 industrial personnel in North-Central Nigeria. Data were collected using a structured questionnaire titled Objectives and Content Required for Thinking-Based Learning Module Questionnaire (OCRTBLMQ). The instrument was face- and content-validated by three experts in technical education, curriculum and instruction, and measurement and evaluation. Its internal consistency was determined using Cronbach's alpha reliability coefficient. Data were analyzed using mean and standard deviation to answer the research questions, while an independent-samples t-test was used to test the null hypotheses at the 0.05 level of significance. The findings revealed that instructional objectives relating to critical thinking, problem-solving, decision-making, creativity, technical competence, reflective learning, safety consciousness, collaboration, and higher-order thinking were required for developing the TBL module. The findings further showed that content relating to workshop safety, fabrication tools and materials, measurement and marking-out, technical drawing, fabrication operations, welding processes and techniques, quality control, entrepreneurship, and thinking-based learning activities was required. The t-test results indicated no significant difference between the mean ratings of fabrication and welding trade teachers and industrial personnel regarding the identified objectives and content requirements. The study concluded that clearly defined thinking-oriented objectives and relevant technical content are fundamental to developing a contextually relevant TBL module for fabrication and welding trade. It was recommended that the identified objectives and content requirements should be used as the basis for designing, developing, and subsequently validating a Thinking-Based Learning module for use in technical colleges.*

Keywords: Thinking-Based Learning, instructional objectives, content required, fabrication and welding trade, technical colleges, module development, North-Central Nigeria.

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I. Introduction

Thinking-Based Learning (TBL) has become an important instructional approach in technical and vocational education due to the increasing demand for graduates who can think critically, solve complex problems, and apply knowledge in real-life industrial situations. TBL emphasizes the deliberate integration of thinking skills such as critical thinking, problem-solving, decision-making, and creativity into classroom instruction rather than focusing solely on rote memorization of facts (Swartz, 2019). In technical education, where practical competence is essential, TBL provides a framework for linking cognitive processes with hands-on skill acquisition.

In recent studies, TBL has been recognized as an effective approach for improving students' higher-order thinking skills and employability in technical fields (Mendoza, 2023). It encourages learners to analyze tasks, evaluate alternatives, and make informed decisions during practical activities. This is particularly relevant in fabrication and welding trade, where precision, safety awareness, and problem-solving are critical to successful task completion.

Fabrication and welding trade are core trade areas in technical colleges that involve the shaping, joining, and assembling of metal components for industrial and construction purposes. These trades require not only psychomotor skills but also strong cognitive abilities to interpret technical drawings, select appropriate materials, apply correct welding techniques, and ensure quality control. However, despite the importance of these competencies, many students in technical colleges still demonstrate weak problem-solving and decision-making abilities upon graduation. This challenge has been linked to the continued use of traditional teaching methods that emphasize demonstration, memorization, and repetition rather than active thinking-based instruction (Nwogu &Uzoagulu, 2019). This gap in instructional approach has contributed to graduates who are often less prepared to meet the cognitive and practical demands of modern industrial workplaces. Given these challenges, integrating TBL into fabrication and welding trade instruction is essential for improving learning outcomes. The objectives of a Thinking-Based Learning module in fabrication and welding trade therefore include developing students' critical thinking skills, enhancing problem-solving and decision-making abilities, promoting creativity and innovation in metal work processes, and strengthening technical competence in workshop practices. It also aims to foster higher-order thinking skills that enable learners to adapt to modern industrial demands.

The content required for such a module includes workshop safety practices, identification and use of tools and materials, measurement and marking-out techniques, interpretation of technical drawings, fabrication processes, welding techniques, quality control procedures, and entrepreneurship skills relevant to metal work industries. In addition, structured TBL activities such as case studies, problem-solving tasks, and project-based learning exercises are essential to support active engagement and skill development. In North-Central Nigeria, where technical colleges are expected to produce skilled artisans for industrial development, the integration of TBL into fabrication and welding trade instruction is particularly important. It provides a pathway for bridging the gap between theoretical knowledge and practical application, thereby improving the quality of technical education and enhancing graduates' employability (Aina& Yusuf, 2022).

Statement of the Problem

Technical colleges are expected to prepare learners with the competencies required for effective participation in industry and self-employment. In fabrication and welding trade, this expectation extends beyond the ability to perform routine workshop operations. Graduates are required to interpret technical information, select appropriate materials and processes, identify and correct welding defects, troubleshoot problems, observe safety requirements, and make appropriate technical decisions. Recent evidence from Nigeria indicates that fabrication and welding trade graduates require both technical and soft skills to perform effectively in industrial environments. Sini and Yakubu (2024), for example, found that technical college graduates in fabrication and welding trade required substantial technical and soft skills for workplace performance and recommended improvements in training facilities and teacher capacity.

However, the development of these broader competencies presents a challenge when instruction is predominantly focused on demonstrating procedures and reproducing established workshop practices. Although practical skill acquisition remains fundamental to fabrication and welding trade education, contemporary TVET requires learners to develop the capacity to analyze situations, solve problems, evaluate alternatives, and adapt their knowledge to unfamiliar workplace situations. López et al. (2023) observed that critical thinking has traditionally received less attention in TVET because the acquisition of practical skills is often prioritized. Their study demonstrated that instructional approaches involving active participation, interaction and explicit attention to thinking skills can improve critical-thinking development among TVET learners.

The problem is particularly relevant to fabrication and welding trade because many workplace tasks require learners to think beyond the mechanical execution of procedures. Welding defects, inaccurate measurements, inappropriate joint preparation, equipment malfunction and deviations from technical specifications require workers to identify problems, determine possible causes, evaluate alternatives and select appropriate solutions. Evidence from Nigerian technical colleges supports this concern. Nwaodo et al. (2024) identified problem-solving, communication, self-management and critical-thinking skills among the work skills required by welding and fabrication students, indicating that technical competence alone may not adequately prepare learners for employment.

Furthermore, the Nigerian government and technical education stakeholders have recently emphasized the need to address skills gaps and align welding training with contemporary industry requirements. In 2024, the National Board for Technical Education highlighted welding as an important skill area and called for increased training of welders to address skills gaps. The Federal Government has also emphasized modernizing welding training, developing industry-aligned curricula, and strengthening practical training and human-capital development in the welding and metals sect

Despite these developments, a specific problem remains. Existing studies have largely examined work-skill needs, employability skills, instructional strategies, facilities, achievement and retention, but there is limited empirical evidence identifying the specific instructional objectives and content that should constitute a

Thinking-Based Learning module specifically for fabrication and welding trade in technical colleges in North-Central Nigeria. For example, Sini and Yakubu (2024) focused on work-skill needs, while Nwaodo et al. (2024) examined work skills including problem-solving and critical thinking. These studies establish the importance of broader competencies but do not provide a systematic set of objectives and content requirements for developing a TBL module.

The absence of such empirically established objectives and content creates a gap in instructional module development. Without clearly defined objectives, it may be difficult to determine the thinking competencies students should acquire, while inappropriate or incomplete content may limit the module's relevance to actual fabrication and welding trade practices. There is therefore a need to obtain the views of those directly involved in training and employing fabrication and welding trade personnel. Involving fabrication and welding trade teachers and industrial personnel can provide both educational and workplace perspectives on the knowledge, skills and thinking competencies that should be incorporated into the proposed module.

It is against this background that the present study investigates the objectives and content for the development of a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.

Aim and Objectives

The aim of this study is to determine the objectives and content required for developing a Thinking-Based Learning module in fabrication and welding tradein technical colleges in North- Central Nigeria.

Objectives of the Study

The study seeks to:

1. Determine the instructional objectives required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.
2. Identify the content required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.

Research Questions

The following questions are developed to guide the study:

1. What instructional objectives are required for developing a Thinking-Based Learning module in teaching fabrication and welding trade in technical colleges in North-Central Nigeria?
2. What content is required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria?

Hypotheses

The following null hypotheses were formulated to guide the study and were tested at 0.05 level of significance.

H_{01}: There is no significant difference in the mean responses of fabrication and welding trade teachers and industrial personnel on the instructional objectives required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.

H_{02}: There is no significant difference in the mean responses of fabrication and welding trade teachers and industrial personnel on the content required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.

II. Literature Review

The review of related literature was organized under the following sub-headings:

a) Concept of Thinking-Based Learning
b) Thinking-Based Learning in Technical and Vocational Education
c) Instructional Objectives Required for Developing a Thinking-Based Learning Module
d) Opposition and Critical Views on Thinking-Oriented Objectives
e) Content Requirements for a Thinking-Based Learning Module
f) Thinking Activities as Content Components
g) Opposition and Critical Views on Content Expansion
h) Empirical Review and Research Gap

Concept of Thinking-Based Learning

Thinking-Based Learning (TBL) is an instructional orientation that deliberately integrates the development of thinking processes with the learning of subject-matter content. Rather than presenting learners with information and procedures to memorize and reproduce, the approach encourages them to analyze

information, make connections, evaluate alternatives, solve problems, make decisions, and reflect on the outcomes of their actions.

The relevance of this approach to technical and vocational education has increased because contemporary workplaces require employees who can apply technical knowledge in changing and unfamiliar situations. In fabrication and welding trade, for example, workers are expected not only to perform established procedures but also to interpret drawings, diagnose faults, select suitable materials and processes, assess risks, identify welding defects, and determine appropriate corrective actions.

López et al. (2023) observed that critical thinking is difficult to develop in Technical and Vocational Education and Training (TVET) because practical skill acquisition is often given priority. Their study, however, demonstrated that explicitly linking learning outcomes to critical-thinking sub-skills and using interactive, participatory instructional activities improved students' critical-thinking performance compared with traditional teaching. This provides empirical support for integrating thinking processes into vocational instruction rather than treating them as separate competencies

Similarly, Tommasi et al. (2023), in a systematic scoping review of initial vocational education and training, noted that the strong emphasis on technical knowledge and occupational skills may result in insufficient attention to metacognitive competencies such as critical thinking. Their review identified the need for deliberate educational interventions to strengthen such competencies among vocational learners. Thus, within the context of the present study, Thinking-Based Learning may be regarded as an instructional approach through which students learn fabrication and welding trade knowledge and practical skills while simultaneously developing critical, analytical, creative, reflective, and problem-solving abilities.

Thinking-Based Learning in Technical and Vocational Education

TVET is traditionally associated with the acquisition of occupational knowledge and practical skills. However, technological advancement and changing industrial practices have increased the importance of transferable competencies. These include critical thinking, creativity, communication, collaboration, decision-making, and adaptability.

López et al. (2023) argued that the traditional emphasis on practical competence in TVET may create difficulties in developing critical thinking because students may become accustomed to following established procedures rather than examining the reasoning underlying them. Their findings nevertheless showed that active and interactive learning can support critical-thinking development within a vocational context.

A recent systematic literature review by Taqwa, *et al* (2026) also mapped research on communication, collaboration, critical thinking, and creativity within TVET, illustrating the increasing prominence of these competencies in vocational education research. The review supports the position that vocational education is increasingly expected to combine occupational competence with broader twenty-first-century capabilities.

Furthermore, Anthony et al. (2025), in a meta-analysis of 30 studies, reported an overall positive effect of problem-based learning on critical-thinking development in vocational education. Their findings provide support for instructional designs that require students to engage with authentic problems rather than merely receive demonstrations and reproduce predetermined procedures.

These findings are relevant to fabrication and welding trade because many workshop and industrial activities involve practical problems that do not always have a single predetermined solution. A learner may be required to determine why a weld has failed, select an appropriate welding process, adjust operating parameters, or identify the cause of dimensional inaccuracies. A Thinking-Based Learning module could therefore provide structured opportunities for learners to apply cognitive processes to authentic fabrication and welding trade problems.

Instructional Objectives Required for Developing a Thinking-Based Learning Module

Instructional objectives describe the expected learning outcomes of instruction. They provide direction for content selection, instructional activities, learning resources, and assessment. In a Thinking-Based Learning module, objectives should go beyond the performance of routine technical operations to include the cognitive processes through which learners analyze, evaluate, decide, create, and reflect.

The findings of López et al. (2023) particularly support the importance of explicitly specifying thinking-related learning outcomes. Their intervention connected course learning outcomes with identifiable critical-thinking sub-skills. The improvement reported among students suggests that thinking skills are more likely to be developed when they are deliberately represented in instructional objectives rather than assumed to emerge automatically from practical activities.

Similarly, Korotaj (2026) developed a contextualized model for teaching critical thinking in vocational education and training. The work emphasizes the need to contextualize learning outcomes and teaching practices according to the specific characteristics of vocational subjects. This is particularly relevant to fabrication and

welding trade, where thinking objectives should emerge from occupational situations rather than be transferred mechanically from general academic subjects.

Based on the literature and the nature of fabrication and welding trade, instructional objectives for a TBL module may include the ability of students to: identify fabrication and welding trade problems; analyze the causes of technical faults and welding defects; apply reasoning in selecting appropriate tools, materials, and processes; evaluate alternative fabrication and welding trade procedures; solve practical workshop problems systematically; make informed technical decisions; interpret drawings and specifications; assess risks and apply safety principles; evaluate the quality of completed products and welds; generate creative solutions to technical problems; reflect on performance and identify areas for improvement; and integrate theoretical knowledge with practical performance. These objectives address both technical competence and higher-order thinking, thereby making them appropriate foundations for the proposed module.

Opposition and Critical Views on Thinking-Oriented Objectives

Although there is considerable support for integrating higher-order thinking into vocational education, an important opposing view is that TVET should primarily focus on occupation-specific practical competence. From this perspective, excessive emphasis on abstract critical-thinking objectives may reduce the time available for students to master essential manual and technical skills. This concern is reflected indirectly in the findings of López et al. (2023), who noted that practical skill acquisition has traditionally been prioritized in TVET and that critical thinking has consequently been difficult to integrate. The authors did not argue that practical skills should be replaced; rather, their study showed the challenge of balancing practical competence with explicit thinking development.

A second critical concern is that critical thinking is not necessarily a completely general skill that automatically transfers across different contexts. A student may demonstrate analytical ability in a classroom discussion but fail to apply similar reasoning during a welding operation unless the thinking process is taught within the relevant technical context. Korotaj's (2026) contextualized model for vocational education reinforces the importance of embedding critical-thinking outcomes in the realities of specific vocational subjects.

Therefore, the implication for the present study is that the proposed objectives should not simply include broad terms such as develop critical thinking. They should be expressed as observable and context-specific objectives, such as analyzing welding defects, evaluating alternative joining methods, selecting appropriate fabrication procedures, and troubleshooting workshop problems.

The present study adopts this balanced position: thinking-oriented objectives should complement, rather than replace, psychomotor and technical objectives.

Content Requirements for a Thinking-Based Learning Module

Content is the body of knowledge, skills, procedures, experiences, and learning tasks through which instructional objectives are achieved. The quality and relevance of content are particularly important in module development because content determines what learners encounter and the situations in which they practice and apply their knowledge. For a fabrication and welding trade TBL module, content cannot be limited to theoretical descriptions of workshop procedures. It should include technical subject matter and authentic learning experiences through which students can practice thinking. Based on the requirements of fabrication and welding trade work, relevant content areas include:

Workshop safety and occupational practices; Hazard identification and risk assessment; Fabrication tools, equipment, and engineering materials; Measurement and marking-out; Interpretation of technical drawings and welding symbols; Metal cutting, bending, forming, fitting, and assembly; Welding principles and processes; Welding joint preparation and welding positions; Identification and correction of welding defects; Welding inspection and quality control; Problem-solving and troubleshooting activities; Decision-making and reflective learning activities; Project-based and collaborative tasks; and Cost estimation and entrepreneurship.

The relevance of embedding authentic problems within vocational content is supported by Anthony et al. (2025), whose meta-analysis found that problem-based learning positively influenced critical-thinking development in vocational education. This suggests that vocational content should not be organized exclusively as procedures for learners to memorize but should include problems requiring analysis and decision-making.

Nurtanto et al. (2026), in a systematic literature review, further reported that literacy-related learning can contribute to analytical, reflective, and evaluative thinking among vocational students. Although their review focused specifically on reading literacy, its broader implication is that vocational learning requires learners to engage meaningfully with information and evidence rather than focus exclusively on hands-on performance.

Thinking Activities as Content Components

A distinctive feature of a Thinking-Based Learning module is that thinking activities themselves are embedded within technical content. Consequently, the proposed module should contain not only what students must know and do, but also activities that require them to reason about what they know and do. Such activities may include: diagnosing the causes of welding defects; comparing alternative welding methods; selecting materials for a particular fabrication project; analyzing safety hazards; solving measurement and marking-out problems; evaluating the quality of fabricated products; investigating equipment faults; developing alternative designs; defending technical decisions; and reflecting on errors and completed practical tasks.

López et al. (2023) found that interactive learning and active student participation supported critical-thinking development in TVET. The implication is that a module should provide opportunities for dialogue, questioning, reasoning, application, and reflection rather than present technical information only in a linear, teacher-directed format. Tommasi et al. (2023) likewise identified a range of educational practices and strategies relevant to developing critical-thinking and metacognitive competencies in initial vocational education. Their systematic review supports deliberate instructional intervention rather than assuming that exposure to vocational content automatically produces higher-order thinking.

Opposition and Critical Views on Content Expansion

An opposing concern regarding comprehensive TBL content is the possibility of curriculum overload. Fabrication and welding trade already contain substantial practical and theoretical content. Adding problem-solving tasks, case studies, reflective exercises, entrepreneurship, collaboration, and explicit critical-thinking activities could make the module too extensive for the available instructional time. This concern means that the proposed module should not merely add more topics to an existing curriculum. Instead, thinking activities should be integrated into existing technical content. For example, rather than teaching welding defects as a list for memorization, students can be presented with defective weld samples and asked to identify probable causes and recommend corrective measures. Thus, the same technical content simultaneously supports skill acquisition and thinking development.

A second opposing view concerns the appropriateness of highly sophisticated instructional activities where workshop facilities, instructional resources, and teacher preparation are inadequate. A problem-based or project-based module may be difficult to implement effectively if learners lack access to materials, equipment, or sufficient practical time. Therefore, the identification of content requirements must take account of local instructional and industrial realities. Finally, some scholars caution that not every thinking activity necessarily improves practical competence. A poorly designed problem-solving activity may become theoretical and disconnected from workshop performance. The contextualized approach proposed for VET by Korotaj (2026) is relevant here because it emphasizes adapting critical-thinking instruction to vocational subject characteristics
Accordingly, the present study assumes that thinking-oriented content is most valuable when it is directly connected to authentic fabrication and welding trade tasks.

Empirical Review and Research Gap

The reviewed literature demonstrates increasing interest in integrating higher-order thinking into vocational education. López et al. (2023) provided evidence that explicitly designed learning outcomes and active learning strategies can improve critical thinking in a TVET context. Tommasi et al. (2023) reviewed interventions for enhancing critical-thinking and metacognitive competencies in initial vocational education, while Anthony et al. (2025) reported positive effects of problem-based learning on vocational students' critical thinking. Recent reviews also indicate growing attention to the broader set of communication, collaboration, creativity, and critical-thinking competencies in TVET.

Nevertheless, these studies have largely focused on the effects of instructional strategies or interventions. They do not specifically determine the instructional objectives and content requirements needed as the foundation for developing a Thinking-Based Learning module in fabrication and welding trade in the context of Nigerian technical colleges. This creates an important gap. Before developing a module, it is necessary to establish what the module should specifically enable learners to achieve and what content should be included. Furthermore, the views of fabrication and welding trade teachers provide an educational perspective, while industrial personnel provide a workplace and occupational perspective. Comparing these perspectives can help establish whether the identified requirements have support across training and employment contexts.
The present study therefore addresses this gap by determining:
the instructional objectives required for developing a Thinking-Based Learning module in fabrication and welding trade; and the content required for developing the module in technical colleges in North-Central Nigeria.

Theoretical Framework

The theoretical framework provides the underlying foundation for explaining the concepts and relationships investigated in a study. It guides the understanding of how learning occurs and how the variables of the study are related. The present study, which focuses on the objectives and content required for developing a Thinking-Based Learning module in fabrication and welding trade, is anchored on theories that emphasize active knowledge construction and the development of higher-order cognitive processes. Specifically, the study is underpinned by Constructivist Learning Theory and supported by Bloom's Revised Taxonomy. These frameworks provide a basis for identifying appropriate instructional objectives and content that can promote critical thinking, problem-solving, analysis, decision-making, and practical competence among fabrication and welding trade students.

Constructivist Learning Theory

The study is anchored primarily on Constructivist Learning Theory, associated with the works of Jean Piaget and Lev Vygotsky. Constructivism views learning as an active process through which learners construct meaning and knowledge based on their experiences, existing knowledge, interaction with others, and engagement with their environment.

From a constructivist perspective, learners should not be regarded as passive recipients of information. Instead, they should actively participate in investigating problems, testing ideas, discussing alternatives, making decisions, reflecting on experiences, and constructing understanding. The teacher therefore serves principally as a facilitator who creates learning situations that stimulate inquiry, collaboration, experimentation, and reflection.

This theory is relevant to fabrication and welding trade because learning in the trade involves more than listening to explanations or copying demonstrations. Students are expected to interact with tools, equipment, materials, drawings, machines, welding processes, and real workshop problems. Through these interactions, they acquire practical knowledge and develop technical competence. For example, instead of merely telling students the causes of a defective weld, a constructivist Thinking-Based Learning activity may require students to: observe a defective weld; identify the type of defect; investigate its possible causes; discuss alternative corrective actions; select the most appropriate solution; apply the solution during practical work; and reflect on the outcome. Such an activity enables students to construct technical understanding while simultaneously developing problem-solving, analytical, decision-making, and reflective abilities.

The theory is particularly relevant to the content requirements of the present study. The content of the proposed module should therefore not consist exclusively of facts, definitions, and procedures. It should incorporate practical problems, investigations, projects, collaborative activities, case situations, experimentation, troubleshooting tasks, and reflective exercises. These learning experiences provide opportunities for students to construct and apply knowledge in meaningful technical situations.

Constructivism also supports the involvement of industrial personnel in identifying module requirements. While teachers contribute knowledge of curriculum, pedagogy, and students' learning needs, industrial personnel provide perspectives based on authentic workplace practices and occupational problems. Combining these perspectives can assist in identifying objectives and content that are educationally appropriate and industrially relevant.

Relevance of Constructivist Theory to the Study

Constructivist Learning Theory supports the study in the following ways:

i. It supports active learning rather than passive memorization.
ii. It provides a basis for integrating problem-solving and inquiry activities into fabrication and welding trade instruction.
iii. It supports the use of authentic workshop and industrial problems as learning experiences.
iv. It emphasizes the importance of collaboration and interaction.
v. It supports reflection and self-evaluation following practical activities.
vi. It provides a theoretical basis for identifying content that enables students to construct and apply technical knowledge.

Thus, Constructivist Learning Theory provides the principal explanation for how the Thinking-Based Learning module should facilitate learning.

Bloom's Revised Taxonomy model

The second model supporting the study is Bloom's Revised Taxonomy, developed by Anderson and Krathwohl (2001) as a revision of Bloom's original taxonomy of educational objectives. The revised taxonomy classifies cognitive learning processes into six hierarchical categories:

Remembering, Understanding, Applying, Analyzing, Evaluating, Creating

The first three categories are commonly associated with foundational cognitive processes, whereas analyzing, evaluating, and creating represent higher-order cognitive processes. These higher-order processes are

particularly relevant to Thinking-Based Learning. The taxonomy is appropriate for the present study because the first variable concerns the instructional objectives required for developing the module. Educational objectives should clearly specify the cognitive and practical competencies students are expected to achieve. Bloom's Revised Taxonomy model provides a systematic framework for formulating such objectives. For example, a conventional fabrication and welding trade objective may require a student to: Identify different types of welding joints. A more thinking-oriented objective may require a student to: Analyze the suitability of different welding joints for a specified fabrication task. Similarly, instead of: State the causes of welding defects. A Thinking-Based Learning objective may be: Evaluate the probable causes of observed welding defects and recommend appropriate corrective measures. The second objective requires learners to move beyond remembering information towards analysis, evaluation, and decision-making. Application to Fabrication and welding trade

The six cognitive levels can be integrated into fabrication and welding trade instruction as follows:

Cognitive Process: Application to Fabrication and welding trade

Remembering: Recall welding symbols, tools, materials and safety rules

Understanding: Explain welding principles and fabrication procedures

Applying: Use appropriate tools and welding procedures

Analyzing: Analyze causes of welding defects and workshop problems

Evaluating: Evaluate alternative processes and product quality

Creating: Develop solutions, designs or fabrication projects

The taxonomy therefore provides a framework for determining the thinking-oriented instructional objectives that should be included in the proposed module.

Relevance of Bloom's Revised Taxonomy model to the Study

Bloom's Revised Taxonomy model is relevant because it: provides a basis for formulating measurable instructional objectives; supports progression from lower-order to higher-order thinking; assists in aligning objectives with instructional content and learning activities; encourages the development of analytical, evaluative, and creative thinking; supports the integration of cognitive processes with technical and practical learning. Thus, Bloom's Revised Taxonomy principally explains what level of learning and thinking the instructional objectives should promote.

Integration of the Theory and model

The theory and model complement each other in supporting the present study.

Constructivist Learning Theory explains how students learn through active engagement, experience, problem-solving, interaction, and reflection. Bloom's Revised Taxonomy model explains the cognitive levels and learning outcomes that instructional objectives should address, particularly progression towards analyzing, evaluating, and creating. Together, they provide a theoretical foundation for identifying the objectives and content required for the development of a Thinking-Based Learning module. The module should therefore contain: clearly stated objectives progressing towards higher-order thinking; relevant fabrication and welding trade content; authentic workshop problems; practical and inquiry-based activities; opportunities for analysis and decision-making; collaborative learning activities; and reflection and evaluation.

Conceptual Framework

The conceptual framework of the study is based on the relationship between the identified instructional objectives and content requirements and the development of a Thinking-Based Learning module.

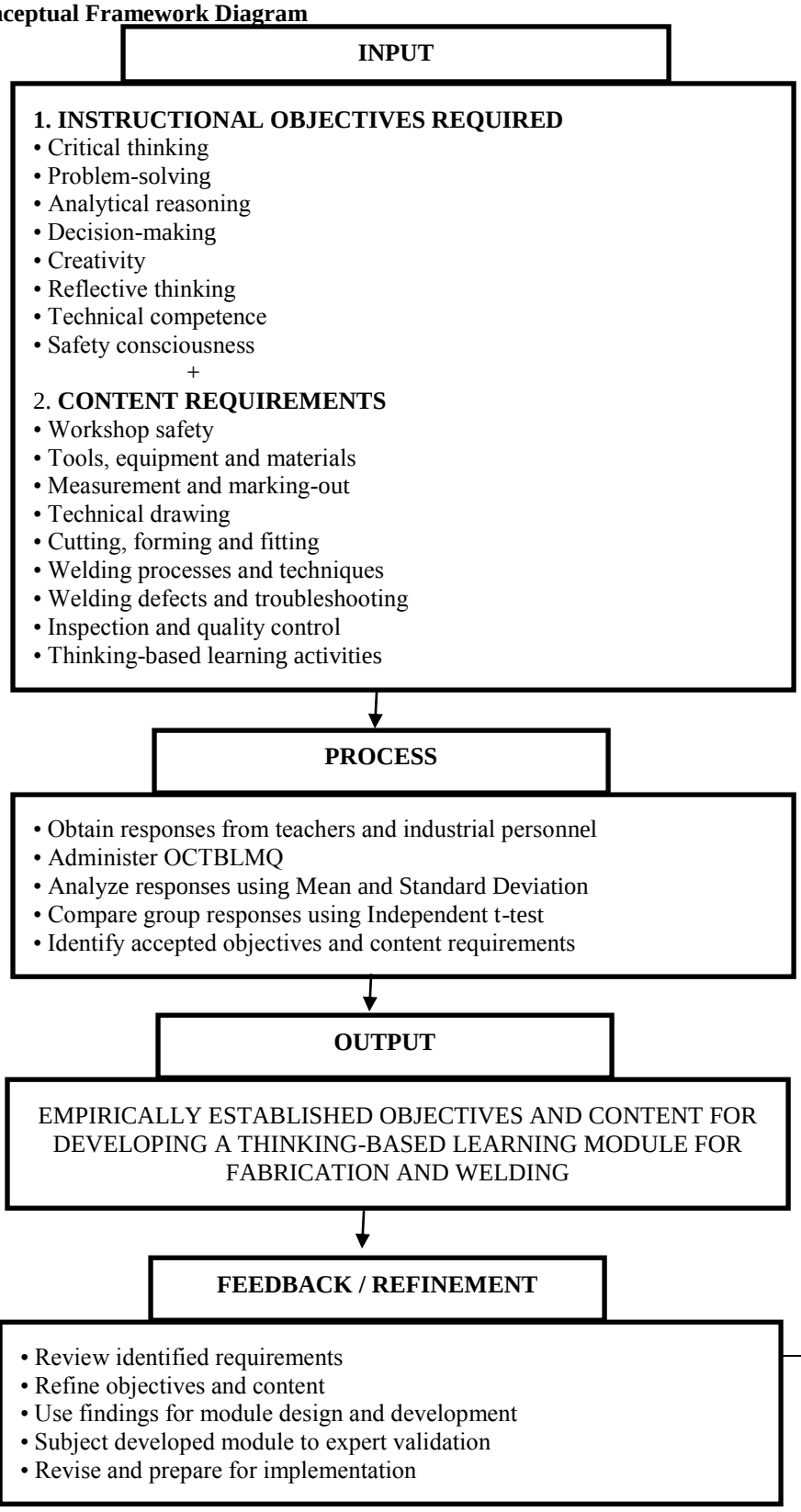
The framework assumes that a relevant and effective Thinking-Based Learning module can be developed when appropriate instructional objectives and content requirements are systematically identified from both educational and industrial perspectives.

The inputs are the two major variables investigated: Instructional objectives required; and Content required. The instructional objectives include competencies such as: critical thinking; problem-solving; analytical reasoning; decision-making; creativity; reflective thinking; technical competence; and safety consciousness. The content requirements include areas such as: workshop safety; tools, equipment, and materials; measurement and marking-out; technical drawing and interpretation; cutting, forming, and fitting; welding processes and techniques; welding defects and troubleshooting; inspection and quality control; and thinking-based practical activities. The process involves obtaining the opinions of fabrication and welding trade teachers and industrial personnel through the administration of the questionnaire, analyzing their responses using mean and standard deviation, and comparing their mean ratings using the independent-samples t-test.

The output is an empirically established set of objectives and content requirements that can serve as the basis for developing a contextually relevant Thinking-Based Learning module for fabrication and welding trade

in technical colleges. A feedback component allows the identified requirements to be reviewed and refined before they are used in the subsequent design, development, validation, and implementation of the module.

Conceptual Framework Diagram



Summary of the Framework

The framework proposes that appropriate instructional objectives and content requirements (inputs), when systematically determined through the views of fabrication and welding trade teachers and industrial personnel (process), will produce an empirically supported foundation (output) for developing the Thinking-Based Learning module. The feedback stage ensures that the identified requirements can be refined before the module is subsequently designed and validated.

III. METHODOLOGY

This section presents the procedures adopted for the study on Objectives and Content Required for Developing a Thinking-Based Learning Module in Fabrication and welding trade in Technical Colleges in North-Central Nigeria. It describes the research design, population, sample and sampling technique, instrumentation, validation and reliability of the instrument, data collection procedure, and methods of data analysis used to address the objectives of the study.

Research Design

The study adopted a Research and Development (R&D) research design. The R&D design was considered appropriate because the study constitutes the initial phase of a systematic process for developing and validating a Thinking-Based Learning (TBL) module for teaching fabrication and welding trade in technical colleges in North-Central Nigeria. The present study focused specifically on establishing the instructional objectives and content requirements that would provide an empirical foundation for the subsequent design and development of the module.

Area of the Study

The study was conducted in North-Central Nigeria. The zone comprises Benue, Kogi, Kwara, Nasarawa, Niger, and Plateau States, together with the Federal Capital Territory. The area was selected because technical colleges within the zone provide training in fabrication and welding trade, making it appropriate for obtaining information from teachers directly involved in the teaching of the trade and industrial personnel familiar with workplace requirements.

Population of the Study

The population of the study comprised 52 respondents, consisting of 31 fabrication and welding trade teachers in technical colleges and 21 industrial personnel with relevant experience in fabrication and welding trade. The inclusion of both groups was intended to obtain perspectives from educational practitioners and industry practitioners regarding the objectives and content that should form the basis of the proposed Thinking-Based Learning module.

Population Distribution

Category	**Population**
Teachers	31
Industrial personnel	21

Sample Size and Sampling Technique

Census sampling technique was used because the population was manageable and specialized. A total of 52 copies of the questionnaire were distributed to the respondents, and all 52 copies were dully completed and returned, representing 100% response rate. The high response rate was achieved through direct administration and retrieval of the questionnaire by the trained research assistants.

Instrument for Data Collection

Data were collected using a structured questionnaire titled Objectives and Content for Thinking-Based Learning Module Questionnaire (OCTBLMQ). The questionnaire was developed by the researcher based on the

objectives of the study, relevant literature on Thinking-Based Learning, and the knowledge and skills required in fabrication and welding trade.
The questionnaire consisted of two major sections:
Section A: Respondents' demographic information.
Section B: This section consists of Items on the instructional objectives required for the development of the TBL module.
Section C: This section consists of Items on the content required for the development of the TBL module.
The questionnaire items were rated on a five-point Likert scale as follows:

Scale	**Value**
Strongly Required	5
Required	4
Moderately Required	3
Less Required	2
Not Required	1

Validity of the Instrument

The questionnaire was subjected to face and content validation by three experts. The experts comprised specialists with relevant expertise in fabrication and welding trade/technical education, curriculum and instruction, and measurement and evaluation. They examined the questionnaire items for clarity, relevance, appropriateness, adequacy of coverage, and alignment with the objectives of the study. Their observations and suggestions were used to modify the instrument before its administration.

Reliability of the Instrument

The internal consistency of the questionnaire was established using the Cronbach's alpha reliability coefficient. The instrument was subjected to a pilot test using respondents who were comparable to those in the main study but were not included in the final study sample. The responses obtained from the pilot administration were analyzed using Cronach's alpha. The resulting coefficient was used to determine the internal consistency of the questionnaire items. A coefficient of 0.70 or above was considered acceptable for the study.

Data Collection Procedure

The questionnaire was administered to the 52 respondents comprising 31 fabrication and welding trade teachers and 21 industrial personnel. The researcher, with the assistance of trained research assistants distributed and retrieved the completed questionnaires. Respondents were informed about the purpose of the study and were requested to provide honest responses based on their professional experience.

Method of Data Analysis

Data collected were analyzed using mean, standard deviation, and independent-samples t-test. Mean and standard deviation were used to answer the two research questions. The decision rule was based on the following five point likert scale:

Scale	**Response**	**Decision Range**
5	Strongly Required	4. 50- 5.00
4	Required	3.50- 4.49
3	Moderately Required	2.50- 3.49
2	Less Required	1.50- 2.49
1	Not Required	1.00- 1.49

A mean score of 3.50 and above was considered Required, while a mean score below 3.50 was considered below the required level. Standard deviation was used to determine the degree of variation in the respondent's ratings. Before conducting the independent-samples t-test, its underlying assumptions were considered. The assumption of normality was examined to determine whether the responses of Fabrication and welding trade teachers and industrial personnel were approximately normally distributed. Independence of observations was ensured by treating each respondent's response as independent, with no respondent participating more than once. Homogeneity of variance was assessed using Levene's test to determine whether the variances of the two groups were sufficiently equal. Where the assumptions were satisfied, the independent-samples t-test was used to determine whether significant differences existed between the mean responses of the two groups at the 0.05 level of significance.

IV. Results / Findings

Research Question 1

What instructional objectives are required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria

Table 1 shows the Mean and Standard Deviation of the respondents on the Instructional Objectives required for developing a thinking-based learning module in fabrication and welding trade in technical colleges in North-Central Nigeria. The table showed the mean responses of teachers ranging from 4.58 to 4.84, with standard deviation .374 to .502 respectively. The mean responses of Industrial Personnel ranges from 4.57 to 4.86 with standard deviation .359 to .507 respectively. Additionally, the cluster mean of teachers is 4.77 with standard deviation .167, and that of Industrial Personnel is 4.74 with the standard deviation .186. The grand mean of the respondents ranged from 4.65 to 4.83. Therefore, the cluster grand mean is 4.72 which indicates that the instructional objectives identified for developing a Thinking-Based Learning module were required. The respondents are agreed that the module should enable students to identify and analyze fabrication and welding trade problems, apply critical and analytical thinking, make appropriate technical decisions, evaluate alternative procedures, solve practical problems, troubleshoot equipment and welding defects, demonstrate creativity, reflect on their performance, and apply safety principles.

Table 1: Mean and standard deviation of the respondents on the Instructional objectives required for developing a thinking-based learning module in fabrication and welding trade in technical colleges in North- Central Nigeria

S/N	Item Statement	$\bar{x}_T$	SD_T	$\bar{\bar{x}}\bar{l}$	SD_I	$\bar{x}_G$	Remark
1.	Develop critical thinking and problem-solving skills in fabrication and welding trade.	4.74	.445	4.67	.483	4.71	Strongly Required
2.	To enhance student's understanding of fabrication and welding trade concepts and principles.	4.68	.475	4.81	.402	4.73	Strongly Required
3.	To improve students' ability to apply theoretical knowledge to practical problems in fabrication and welding trade.	4.71	.461	4.57	.507	4.65	Strongly Required
4.	To foster creativity, innovation, and analytical decision-making skills in fabrication and welding trade.	4.84	.374	4.81	.402	4.83	Strongly Required
5.	To improve students' safety awareness and practices in fabrication and welding trade	4.71	.461	4.81	.402	4.75	Strongly Required
6.	To develop students' ability to work effectively in teams and communicate effectively about fabrication and welding trade projects.	4.71	.461	4.76	.436	4.73	Strongly Required
7.	To prepare students to apply theoretical knowledge to real-world fabrication and welding trade problems.	4.74	.445	4.71	.463	4.73	Strongly Required
8.	To enhance students' understanding of the role of fabrication and welding trade in various industries.	4.68	.475	4.76	.436	4.71	Strongly Required
9.	To develop students' problem-solving skills in a real-world context.	4.58	.502	4.86	.359	4.69	Strongly Required
10.	To equip students with the skills and knowledge required to succeed in the fabrication and welding trade industry.	4.74	.445	4.67	.483	4.71	Strongly Required
	Cluster Mean	4.77	.167	4.74	.186	**4.72**	**Strongly Required**

Source: Fieldwork, 2026

Research Question 2

What content is required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria?

Table 2 shows the Mean and Standard Deviation of the respondents on the contents required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria. The table showed the mean responses of Teachers ranging from 4.55 to 4.90, with standard deviation also ranges from .301 to .570 and the mean responses of Industrial Personnel ranges from 4.38 to 4.90 while the standard deviation ranges from .301 to .669 respectively. The cluster mean of teachers is 4.70 with standard deviation of .148 while that of Industrial Personnel is 4.67 with standard deviation of .090, the grand mean of the respondents is ranged from 4.58 to 4.84. Therefore, the cluster grand mean is 4.69 indicating that the identified contents by the respondents is strongly required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.

Table 2: Mean and standard deviation of the respondents on thecontents required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges

S/N	Item Statement	X_T	SD_T	X_I	SD_I	X_G	Remark
1.	**PROBLEM-SOLVING SKILLS**						
i.	Identifying common problems in fabrication and welding trade	4.84	.374	4.71	.463	4.79	Strongly Required
ii.	Analyzing causes of defects in welded joints	4.74	.445	4.71	.463	4.73	Strongly

							Required
iii.	Troubleshooting welding equipment issues	4.68	.475	4.71	.463	4.69	Strongly Required
iv.	Resolving material handling problems	4.61	.495	4.67	.483	4.63	Strongly Required
v.	Addressing safety concerns in the workshop	4.68	.475	4.57	.507	4.64	Strongly Required
vi.	Identifying and fixing errors in fabrication designs	4.68	.475	4.67	.483	4.68	Strongly Required
vii.	Finding creative solutions to fabrication challenges	4.65	.551	4.76	.436	4.69	Strongly Required
viii.	Analyzing and resolving quality control issues	4.68	.475	4.67	.483	4.68	Strongly Required
ix.	Identifying and addressing potential hazards	4.58	.564	4.90	.301	4.71	Strongly Required
2.	**CRITICAL THINKING**						
i.	Evaluating the quality of materials for fabrication and welding trade	4.90	.301	4.71	.463	4.84	Strongly Required
ii.	Assessing the effectiveness of different welding techniques	4.81	.402	4.76	.436	4.79	Strongly Required
iii.	Evaluating the safety of fabrication and welding trade procedures	4.81	.402	4.57	.507	4.71	Strongly Required
iv.	Analyzing data to inform fabrication and welding trade decisions	4.55	.506	4.76	.436	4.63	Strongly Required
v.	Assessing the feasibility of fabrication and welding trade projects	4.74	.445	4.67	.483	4.71	Strongly Required
vi.	Analyzing the cost-benefit of different fabrication and welding trade methods	4.77	.425	4.67	.577	4.73	Strongly Required
vii.	Identifying and challenging assumptions in fabrication designs	4.77	.425	4.57	.598	4.69	Strongly Required
viii.	Developing well-supported arguments for fabrication and welding trade decisions	4.65	.486	4.81	.402	4.71	Strongly Required
ix.	Analyzing complex fabrication and welding trade problems	4.65	.486	4.86	.359	4.73	Strongly Required
x.	Making informed decisions about fabrication and welding trade techniques	4.77	.425	4.67	.483	4.73	Strongly Required
3.	**ANALYTICAL DECISION-MAKING**						
i.	Evaluating the risks and benefits of new fabrication and welding trade technologies	4.74	.445	4.62	.498	4.69	Strongly Required
ii.	Analyzing data to inform decisions about fabrication and welding trade	4.71	.461	4.71	.463	4.71	Strongly Required
iii.	Considering multiple perspectives when making fabrication and welding trade decisions	4.65	.486	4.67	.483	4.66	Strongly Required
iv.	Identifying and evaluating alternatives to traditional fabrication and welding trade methods	4.55	.506	4.71	.463	4.61	Strongly Required
v.	Developing decision-making frameworks for fabrication and welding trade	4.81	.402	4.57	.507	4.71	Strongly Required
vi.	Analyzing the cost-effectiveness of different fabrication and welding trade options	4.83	.379	4.71	.463	4.78	Strongly Required
vii.	Identifying and mitigating risks in fabrication and welding trade projects	4.74	.445	4.62	.498	4.69	Strongly Required
viii.	Evaluating the quality of fabrication and welding trade products	4.68	.475	4.62	.498	4.66	Strongly Required
ix.	Evaluating the effectiveness of fabrication and welding trade quality control measures	4.74	.445	4.62	.498	4.69	Strongly Required
x.	Identifying areas for improvement in fabrication and welding trade decision-making	4.77	.425	4.67	.483	4.73	Strongly Required
4.	**DESIGN THINKING**						
i.	Ideating innovative solutions to fabrication and welding trade challenges	4.65	.486	4.67	.483	4.66	Strongly Required
ii.	Prototyping and testing fabrication and welding trade designs	4.58	.502	4.57	.507	4.58	Strongly Required
iii.	Gathering feedback from stakeholders on fabrication and welding trade designs	4.48	.570	4.90	.301	4.63	Strongly Required
iv.	Encouraging creativity and innovation in fabrication and welding trade	4.55	.568	4.62	.590	4.58	Strongly Required
v.	Collaborating with others to develop fabrication and welding trade solutions	4.68	.475	4.86	.359	4.75	Strongly Required
vi.	Evaluating the feasibility of fabrication and welding trade designs	4.71	.529	4.71	.463	4.71	Strongly Required
vii.	Developing sustainable fabrication and welding trade solutions	4.68	.541	4.52	.512	4.62	Strongly Required
viii.	Identifying opportunities for design improvement in fabrication and welding trade	4.68	.475	4.57	.507	4.64	Strongly Required

ix.	Creating prototypes of fabricated and welded products	4.68	.475	4.76	.436	4.71	Strongly Required
x.	Testing and validating fabrication and welding trade designs	4.74	.445	4.52	.602	4.65	Strongly Required
5.	**TROUBLESHOOTING**						
i.	Identifying common issues with welding equipment	4.77	.425	4.57	.507	4.69	Strongly Required
ii.	Diagnosing defects in fabricated and welded products	4.68	.475	4.57	.507	4.64	Strongly Required
iii.	Developing procedures for troubleshooting fabrication and welding trade issues	4.65	.486	4.67	.577	4.66	Strongly Required
iv.	Analyzing data to identify trends and patterns in fabrication and welding trade issues	4.68	.541	4.57	.507	4.64	Strongly Required
v.	Documenting and reporting fabrication and welding trade issues	4.71	.461	4.38	.669	4.58	Strongly Required
vi.	Developing contingency plans for fabrication and welding trade troubleshooting	4.58	.502	4.81	.402	4.67	Strongly Required
vii.	Evaluating the effectiveness of troubleshooting procedures	4.71	.461	4.62	.590	4.67	Strongly Required
viii.	Identifying areas for improvement in fabrication and welding trade troubleshooting	4.77	.425	4.81	.402	4.79	Strongly Required
ix.	Training others on fabrication and welding trade troubleshooting procedures	4.71	.461	4.52	.512	4.63	Strongly Required
	Cluster Mean	4.70	.148	4.67	.091	**4.69**	**Strongly Required**

Source: Field work, 2026

Hypotheses Testing

Hypothesis 1

There is no significant difference between the mean responses of teachers and industrial personnel on the instructional objectives required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.

The result of the independent sample t-test presented in Table 1 showed that there is no significant difference between the mean responses of teachers and industrial personnel on the instructional objectives required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.,within the degree of freedom of 50, t-value = .634, and *p*-value = .529 respectively. Since the *p* value is greater than the confidence level (P>0.05) therefore, the null hypothesis one was accepted. This implied that there is no significant difference between the mean responses of teachers and industrial personnel on the instructional objectives required for developing a Thinking-Based module in fabrication and welding trade in technical colleges in North-Central Nigeria.

Table 3:Independent t-test analysis of the mean responses of teachers and industrial personnel on the instructional objectives required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges

	N	**$\bar{x}$**	**S.D**	**df**	**t-val**	***p*-valu**	**Decision**
Teachers	31	4.77	.167	50	.634	.529	Accepted
Industrial Personnel	21	4.74	.186				

Source: Field Work (2026)

Hypothesis 2

There is no significant difference between the mean responses of teachers and industrial personnel on the contents required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria

The result of the independent sample t-test presented in Table 4 showed that there is no significant difference between the mean responses of teachers and industrial personnel on the contents required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria,within the degree of freedom of 50, t-value = .714, and *p*-value = .479 respectively. Since the *p* value is greater than the confidence level (P>0.05) therefore, the null hypothesis two was also accepted. This implied that there is no significant difference between the mean responses of teachers and industrial personnel on the contents required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges in North-Central Nigeria.

Table 4**: Independent t-test analysis of the mean responses of teachers and industrial personnel on the contents required for developing a Thinking-Based Learning module in fabrication and welding trade in technical colleges**

	N	$\bar{x}$	S.D	df	t-val	*p*-val	Decision
Teachers	31	4.70	.148	50	.714	.497	Accepted
Industrial Personnel	21	4.67	.091				

Source: Field Work (2026)

Findings of the Study

Based on the analysis of data collected from fabrication and welding trade teachers and industrial personnel, the study revealed the following:

i. The instructional objectives identified for the development of a Thinking-Based learning module were strongly required, and the respondents agreed that the module should enable students to identify and analyze fabrication and welding trade problems, apply critical and analytical thinking, make appropriate technical decisions, evaluate alternatives procedures, solve practical problems, troubleshooting equipment and welding defects, demonstrate creativity and apply safety principles.

ii. The identify content areas were strongly required for developing a Thinking-Based Learning module. The required content includes workshop safety, tools and equipment, measurement and marking out, technical drawing and interpretation, cutting, forming, fitting and assembly, welding processes, welding defects, troubleshooting, inspection, quality control and thinking-based practical activities.

The null hypothesis tested showed no significant difference between the mean responses of teachers and industrial personnel regarding instructional objectives and content required for developing a Thinking-Based Learning module in fabrication and welding trade in North-Central Nigeria. This indicates a consensus between both groups on the requirements for a Thinking-Based Learning Module.

V. Discussion of Findings

Instructional Objectives Required for the Development of the Thinking-Based Learning Module

The first finding showed that the instructional objectives required for developing a Thinking-Based Learning module in fabrication and welding trade were strongly required, with a grand mean of 4.72. The identified objectives emphasized critical thinking, analysis, problem-solving, decision-making, evaluation, creativity, troubleshooting, reflection, technical competence, and safety consciousness.The finding demonstrates that effective fabrication and welding trade instruction should extend beyond the acquisition of routine psychomotor skills. Students should be able to understand and respond to practical problems that arise during fabrication and welding trade operations. For example, students may be required to analyze the causes of welding defects, compare alternative joining processes, select suitable materials, diagnose equipment faults, and evaluate the quality of finished products.

The finding is supported by López et al. (2023), who reported that critical thinking can be developed within TVET when expected learning outcomes are explicitly linked to thinking sub-skills and supported through active and participatory learning. Their findings are particularly relevant because they suggest that thinking skills should be deliberately stated as learning outcomes rather than assumed to emerge automatically from practical instruction. The finding also supports the logic of Bloom's Revised Taxonomy, particularly the higher-order cognitive processes of analyzing, evaluating, and creating. Within fabrication and welding trade instruction, these processes can be expressed through objectives requiring students to analyze technical faults, evaluate alternative procedures, and develop appropriate solutions to workshop problems.

The high rating of the instructional objectives further suggests that teachers and industrial personnel recognize the need for a closer relationship between school-based training and the cognitive demands of workplace practice. Industrial fabrication and welding trade work requires employees to respond to variations in materials, equipment conditions, specifications, safety requirements, and production problems. Therefore, a module designed to develop only procedural competence may not adequately prepare students for complex workplace situations. This interpretation is also consistent with Anthony et al. (2025), whose meta-analysis of 30 studies found that problem-based learning had a significant positive effect on critical-thinking development in vocational education. The result supports instructional objectives that deliberately require students to investigate real-world problems, reason through alternatives, and justify technical decisions.

Content Required for the Development of the Thinking-Based Learning Module

The second finding revealed that the identified content areas were strongly required for developing the Thinking-Based Learning module, with a grand mean of 4.69. The required content included safety, tools and equipment, engineering materials, measurement and marking-out, technical drawing, fabrication operations, welding processes, welding defects, troubleshooting, inspection, quality control, and thinking-based practical activities. This finding indicates that the content of the proposed module should be comprehensive and should

integrate cognitive development with technical and practical competencies. The module should therefore not introduce thinking skills as a separate abstract topic. Rather, analytical, problem-solving, evaluative, and reflective activities should be incorporated into the technical content that students are expected to learn.

For example, instead of teaching welding defects solely through definitions and demonstrations, students can be presented with defective weld samples and required to identify the defect, analyze its possible causes, recommend corrective measures, and justify their decisions. Similarly, measurement and marking-out can involve practical problems requiring students to interpret dimensions, identify errors, and determine appropriate corrective actions. This finding is supported by López et al. (2023), who found that active participation and interactive instructional activities facilitated critical-thinking development in a TVET context. Their study reinforces the importance of organizing vocational content around activities that require learners to engage actively with problems rather than merely receive information and reproduce procedures.

The finding is further supported by Anthony et al. (2025), whose meta-analysis reported a positive effect of problem-based learning on vocational students' critical thinking. The implication for the present study is that fabrication and welding trade content should include authentic workshop problems, troubleshooting tasks, collaborative activities, and opportunities for decision-making. The result also addresses a major concern in vocational education: the tendency to separate theory from practical work. The present findings suggest that technical knowledge, practical performance, and thinking processes should be integrated. Students should learn not only how to perform an operation, but also why a particular procedure is appropriate, what alternatives exist, and how problems can be identified and corrected.

Conclusion

Based on the findings of the study, it was concluded that the development of a Thinking-Based Learning module for fabrication and welding trade in technical colleges in North-Central Nigeria requires clearly defined thinking-oriented instructional objectives and relevant technical content.

The instructional objectives should extend beyond the acquisition of routine practical skills to include critical thinking, analytical reasoning, problem-solving, decision-making, evaluation, creativity, troubleshooting, reflection, and safety consciousness. Similarly, the module content should integrate fundamental fabrication and welding trade knowledge and practical operations with authentic problems and learning activities that require students to think, analyze, evaluate, and make informed technical decisions. The findings therefore establish that Thinking-Based Learning in fabrication and welding trade should not be treated as an additional or separate component of technical education. Rather, thinking processes should be systematically embedded within the objectives, content, practical activities, and assessment tasks of fabrication and welding trade instruction.

Where the hypothesis tests show no significant differences between the responses of fabrication and welding trade teachers and industrial personnel, the findings further demonstrate a shared perception between educational and industrial practitioners concerning the requirements for the proposed module. Consequently, the identified objectives and content provide an empirical basis for the subsequent design, development, and validation of a Thinking-Based Learning module for fabrication and welding trade in technical colleges.

Recommendations

The following recommendations are made directly from the findings of the study:

1. The identified instructional objectives should be incorporated into the development of the Thinking-Based Learning module. In particular, objectives relating to critical thinking, analysis, problem-solving, decision-making, evaluation, creativity, troubleshooting, and reflection should be integrated with fabrication and welding trade competencies.
2. The identified content requirements should form the foundation for the module structure. Content on workshop safety, tools and equipment, materials, measurement and marking-out, technical drawing, fabrication processes, welding procedures, welding defects, troubleshooting, inspection, and quality control should be incorporated.
3. Thinking activities should be integrated into technical and practical content rather than taught separately. Fabrication and welding trade topics should include practical problems, case situations, troubleshooting exercises, decision-making tasks, and reflective activities.
4. Teachers should organize practical activities around authentic workshop problems. Students should be provided opportunities to analyze defective products, diagnose welding faults, compare alternative procedures, select appropriate tools and materials, and justify technical decisions.
5. Industrial personnel should participate in subsequent stages of module development and validation. Their involvement will help ensure that the objectives and content of the module remain relevant to contemporary workplace and occupational requirements.
6. The identified objectives and content should be subjected to subsequent module development, expert validation, pilot testing, revision, and implementation before large-scale adoption in technical colleges.

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