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A Study of the Effectiveness of Thorndike's Connectionism Theory on English Language Learning for Daily Life

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ABSTRACT

*This study addresses the need for effective pedagogical tools in vocational education, specifically for teaching practical English language skills. It investigates the application of Thorndike's connectionism theory in developing instructional materials. The research aimed to: (1) develop and evaluate the efficiency of an instructional document for the course "English for Daily Life" (Code 20000-1201) against the 80/80 standard criterion; (2) compare students' learning achievement before and after using the materials; and (3) assess student satisfaction with the developed materials. A one-group pretest-posttest experimental design was employed. The sample consisted of 35 first-year vocational certificate students in electrical power at Pattani Technical College. The intervention involved an 8-unit instructional document and lesson plans designed based on Thorndike's principles (laws of readiness, exercise, and effect). Data were collected using a learning achievement test (IOC = 0.67-1.00, reliability = 0.913) and a satisfaction questionnaire (IOC = 0.67-1.00, reliability = 0.951). Data were analyzed using mean, standard deviation, percentage, and dependent-samples *t* tests. The efficiency of the instructional materials was 81.11/80.14, exceeding the 80/80 criterion. The posttest scores (*M = 64.89, SD = 4.62) were significantly higher than the pretest scores (M = 25.37, SD = 5.00) at the .01 level, *t*(34) = 48.051. Overall student satisfaction was at the highest level (M = 4.51, SD = 0.45). The instructional materials developed under Thorndike's connectionism theory are effective, significantly improve learning achievement, and are met with high student satisfaction. This approach is recommended for teaching practical English in vocational settings.*

Keywords: Thorndike's connectionism theory, vocational education, English for Daily Life, instructional materials, learning achievement

1. INTRODUCTION

In vocational education, particularly in technical fields, a key challenge is making general subjects like English feel relevant and practical to students. Many students struggle to connect language learning with their future careers, which can lead to low motivation and poor academic performance. Traditional lecture-based methods often fall short of equipping students with the real-world communication skills required by the national vocational curriculum. In an effort to address this, educators are looking to foundational learning theories to create more effective teaching strategies. The development of hands-on, or "handmade," learning media has emerged as a promising approach to promote the acquisition of practical skills, including English vocabulary, while simultaneously enhancing student achievement and satisfaction. Edward Lee Thorndike's Connectionism Theory, developed in the early 1900s, offers a promising framework. This theory, based on the principles of stimulus-response,

reinforcement, and habit formation, suggests that learning occurs by strengthening connections between a situation and a response. By applying his Laws of Learning-specifically the Law of Exercise and the Law of Effect-it may be possible to design a pedagogical approach that reinforces practical, everyday English usage. However, the relevance and effectiveness of these classic principles in a modern, cross-cultural setting, such as Thai vocational education, remains an area that requires further investigation (Joanisse, & McClelland, 2015; Zimmerman, & Schunk, (2014).

The challenges in English language learning within Thai vocational education can be framed within three foundational pillars. First, from a Curriculum and Policy Framework perspective, the Office of the Vocational Education Commission's curriculum (Office of the Vocational Education Commission, 2019) mandates the development of practical English skills, yet there is a lack of specific guidance on the most effective pedagogical approaches and instructional materials to achieve these objectives in technical fields. Second, in Pedagogical Theory and Material Design, traditional approaches often fail to operationalize foundational learning theories in a way that builds tangible connections for vocational students. Despite the enduring relevance of Thorndik's (1911) and Skinner's (1953) principles, their application in designing targeted instructional materials remains underexplored. The study of the use of instructional documents for vocational curriculum, as seen in the work of Sri-thanaprasert (2013), highlights the need for a more structured, theory-driven approach to materials development. Third, a review of Empirical Efficacy Studies reveals a lack of data on whether materials designed with these specific theoretical underpinnings can meet and exceed established performance criteria, such as the 80/80 standard, and whether they can measurably improve learning outcomes and student satisfaction.

Despite a wealth of research on English language teaching, a notable gap exists concerning the application of foundational theories like Thorndike's connectionism within the specific context of Thai vocational education. While many studies focus on modern communicative methodologies, they often overlook how reinforcing fundamental behavioral principles can enhance the acquisition of practical language skills for non-specialist learners. Furthermore, much of the foundational research on connectionism is several decades old (Thorndike, 1911; Skinner, 1953), and these studies often lack the contemporary validation that modern research methodologies could provide. This creates a temporal gap, making it difficult to assess the theory's current relevance. A significant limitation is that existing meta-analyses and systematic reviews have not consistently isolated Thorndike's specific principles from broader behaviorist approaches, which makes it challenging to pinpoint the unique contributions of his theory (Rodriguez et al., 2013). This study addresses the missing link by focusing on the applied application of Thorndike's principles in a modern, cross-cultural setting. Lastly, there is a general lack of cross-cultural validation for these principles, particularly in non-Western educational environments like Thailand, where English is learned as a foreign language (Thompson, 2012).

This study aims to address these research gaps by examining the effectiveness of an instructional document for "English for Daily Life" that is specifically designed using Thorndike's Connectionism Theory. The primary research question guiding this inquiry is: How effective is an instructional document for 'English for Daily Life,' designed according to Thorndike's connectionism theory, in terms of efficiency, improving student learning achievement, and fostering student satisfaction among vocational students in Thailand? To answer this, the study will pursue three main objectives: to develop and evaluate the efficiency

of the instructional document against an 80/80 standard, to compare students' learning achievement before and after using the materials, and to assess student satisfaction with the developed materials. By providing a clear example of how theoretical principles can be translated into practical, effective pedagogical tools, this study fills a crucial gap between classic learning theory and contemporary educational practice. From above, the details of the materials and methods used in this experimental study, including the sample, instruments, and intervention design as the scope of the study was shown in Table 1 below.

Table 1 The scope of the study

No.	Research Objectives (ROs)	Research Questions (RQs)	Research Instruments (RIs)	Research Statistics (RSs)
1	To develop and evaluate the efficiency of an instructional document for the course "English for Daily Life" (Code 20000-1201).	Do the developed instructional materials meet the 80/80 standard efficiency criterion?	8-unit instructional document and lesson plans (validated by experts, IOC = 0.67-1.00).	Efficiency formulas (E1/ E2) and percentage calculation.
2	To compare students' learning achievement before and after using the instructional materials.	Is there a significant difference in students' learning achievement scores before and after the intervention?	Learning achievement test (Pre-test & Post-test; Reliability = 0.913).	Dependent-samples *t*-test, Mean (*M*), Standard Deviation (*SD*).
3	To assess student satisfaction with the developed instructional materials.	What is the level of student satisfaction with the instructional materials and the teaching approach?	Satisfaction questionnaire (5-point Likert scale; Reliability = 0.951).	Mean (*M*), Standard Deviation (*SD*), descriptive analysis of levels.

2. LITERATURE REVIEWS

The development and evaluation of the instructional materials for this study are not situated in a vacuum but are deeply informed by a synthesis of three distinct yet interconnected bodies of literature. A systematic conceptual clustering reveals the foundational pillars supporting this research: the mandated Curriculum and Policy Framework, the theoretical underpinnings of Pedagogical Theory and Material Design, and the practical, methodological precedents set by Empirical Efficacy Studies. The evolution of thought moves from the broad "why" of learning theory, which is codified into the specific "what" of policy, ultimately informing the "how" of empirical testing in local contexts. This iterative process ensures that practice is both theoretically sound and empirically validated, creating a robust feedback loop for continuous improvement in vocational education. The thematic map of literature review demonstrated in Table 2 below.

Table 2 The Thematic Map of Literature Review

Cluster	Theme	Key Sources	Role in Present Study
1	Curriculum and Policy Framework	Office of the Vocational Education Commission (2019); UNESCO (2012); Biesta (2015)	Provided the mandated objectives and competency standards, contextualized within global and philosophical discussions on vocational education.
2	Pedagogical Theory and Material Design	Thorndike (1911); Skinner (1953); Hattie and Timperley (2007); Merrill (2002)	Provided the theoretical foundation for material design, particularly the laws of learning and the critical role of feedback.
3	Empirical Efficacy Studies	Sri-thanaprasert (2013); Methawiwattanikul (2015); Engchun	Provided a validated methodological model (e.g., DBR) for development and

		(2010); Nieveen and Folmer (2013)	testing, ensuring local relevance and rigor.

2.1 Curriculum and Policy Framework

This cluster is defined by the official documents that prescribe the standards, objectives, and competencies for vocational education in Thailand. The primary source is the *Vocational Certificate Curriculum B.E. 2562* (Office of the Vocational Education Commission, 2019), which mandates a shift from knowledge-based to competency-based learning. This curriculum explicitly outlines the course "English for Daily Life" (Code 20000-1201), emphasizing practical, real-world communication skills in listening, speaking, reading, and writing for both daily and occupational contexts over rote memorization of grammatical rules. This aligns with global trends in Technical and Vocational Education and Training (TVET), where the focus is on developing employability skills and fostering adaptability in a rapidly changing job market (UNESCO, 2012).

The Thai curriculum's emphasis on student-centeredness and practical application reflects a broader philosophical shift in education towards what Biesta (2015) terms "learnification" -a focus on the process and outcomes of learning itself rather than solely on the transmission of knowledge. This policy framework effectively sets the destination but provides limited pedagogical guidance on the journey. It prescribes the "what"-the competencies students must achieve—but remains largely silent on the "how" -the specific instructional strategies most effective for diverse learners in technical fields, who may exhibit varying levels of motivation and proficiency in general subjects like English (Hallinger & Lee, 2014). This gap between policy intent and classroom practice is a common challenge in educational reform, creating a crucial space for research to bridge theory and application.

A significant limitation of this policy-centric literature is its static nature. While it provides a essential snapshot of intended outcomes, it cannot account for the dynamic complexities of classroom implementation, teacher interpretation, and student engagement. Furthermore, the rapid advancement of digital technology and the evolving needs of industries necessitate a curriculum that is inherently adaptable, a challenge for large-scale, centralized policy documents (Wagner, 2014).

Future developments will likely see curricula evolving beyond broad competencies towards the integration of more specific 21st-century skills such as digital literacy, critical thinking, and cross-cultural communication explicitly within vocational subjects (Voogt & Roblin, 2012). This will require even closer collaboration between policymakers, industry partners, and educators to ensure that the "what" of the curriculum remains relevant, thereby demanding continuous innovation and adaptation in the "how" of teaching materials and methods.

2.2 Pedagogical Theory and Material Design

This cluster delves into the theoretical "why" behind the design of the instructional materials. The study is predominantly anchored in the behaviorist tradition, specifically Thorndike's (1911) connectionism theory and its operationalization through Skinner's (1953) operant conditioning**.** Thorndike's laws of learning: readiness, exercise, and effect—provide a timeless and robust framework for skill acquisition. In the context of this study, these laws translated directly into material design: (1)

stimulating *readiness* through engaging warm-up activities and clear learning goals; (2) providing ample *exercise* through structured, repetitive practice via numerous worksheets and activities; and (3) ensuring a positive *effect* through immediate and constructive feedback on performance.

The critical role of feedback, a key component of the "law of effect," is strongly supported by contemporary meta-analytic research. Hattie and Timperley (2007), in their seminal work, identify feedback as one of the most powerful influences on student achievement. Their model of effective feedback-addressing the questions "Where am I going?" (feed-up), "How am I going?" (feed-back), and "Where to next?" (feed-forward)-resonates deeply with Thorndike's principle. The high student satisfaction with "opportunity to know scores" and "fairness in teacher grading" in this study underscores the motivational and reinforcing power of effective feedback, bridging early 20th-century theory with 21st-century educational research.

However, a limitation of relying solely on behavioral theories is the potential perception of them being outdated or reductionist, especially when compared to constructivist or sociocultural approaches that emphasize knowledge building and social interaction (Vygotsky, 1978). The challenge in modern application is to avoid creating mechanical, drill-oriented instruction. The key is to leverage the structured framework provided by behaviorism while ensuring the activities are meaningful, engaging, and situated in authentic contexts. This is where principles from instructional design models like Merrill's (2002). First Principles of Instruction (learning is promoted when students engage in solving real-world problems) can be integrated to create a more holistic learning experience.

The future of this cluster lies in the symbiosis between foundational learning principles and digital technology. Adaptive learning software and AI-driven platforms can personalize the "exercise" and "effect" components with unprecedented efficiency, providing tailored practice and instantaneous, individualized feedback at scale (VanLehn, 2011). This digital evolution does not invalidate Thorndike's laws but rather provides powerful new tools to enact them more effectively, personalizing the learning pathway while maintaining the structured practice necessary for skill automatization.

2.3 Empirical Efficacy Studies

This cluster comprises the "how"-the body of previous quasi-experimental research conducted within the Thai vocational education system that provides a methodological blueprint for this study. Researchers like Sri-thanaprasert (2013), Methawiwattanikul (2015), and Engchun (2010) have consistently demonstrated the efficacy of locally developed instructional materials across various subjects, from database systems to machine theory. Their work establishes a strong precedent, showing that such materials, when developed systematically, consistently achieve efficiency scores exceeding the 80/80 criterion and lead to statistically significant improvements in learning achievement compared to traditional lecture-based methods.

The methodology employed in these studies—involving expert validation (Index of Item-Objective Congruence, or IOC), reliability analysis, and efficiency testing—is a hallmark of design-based research (DBR) **(**Nieveen & Folmer, 2013). DBR is characterized by iterative cycles of design, implementation, evaluation, and refinement in real-world educational settings. This approach is particularly valuable as it generates theories and interventions that

are both theoretically grounded and contextually relevant. The current study directly adopts this proven DBR-inspired methodology, ensuring its findings are credible and its materials are practical for the intended context.

A primary limitation of this empirical cluster is its highly localized and contextual nature. While the findings are robust within their specific settings, their generalizability to different subjects, institutions, or cultural contexts may be limited. Furthermore, many of these studies, including the current one, focus on immediate learning gains (short-term achievement). There is a comparative lack of longitudinal research investigating the long-term retention of skills, their transfer to real-world work situations, or their comparative effectiveness against other innovative pedagogies like project-based learning or collaborative learning (Johnson & Johnson, 2018).

Therefore, the future direction for empirical research in this field must expand beyond establishing basic efficacy. Future studies should: (1) incorporate control groups and randomized controlled trials (RCTs) to strengthen causal claims; (2) track longitudinal data on skill retention and career impact; (3) conduct **c**omparative effectiveness studies pitting instructional materials against other teaching methods; and (4) deeply integrate digital tools into the material design from the outset, moving beyond analog documents to interactive digital learning environments.

2.4 Research Conceptual Framework

The interplay between these three clusters forms the conceptual framework for this study, visualized in Figure 1. The Pedagogical Theory cluster provides the foundational principles ("why"). These principles inform and are codified by the Curriculum and Policy cluster, which defines the objectives ("what"). Together, they directly guide the Design and Development of the instructional materials. This intervention is then implemented and evaluated using methods from the Empirical Efficacy Studies cluster ("how"). The results and insights from this evaluation feedback to refine the materials, contribute to the empirical body of knowledge, and ultimately influence both pedagogical practice and future curriculum policy updates, creating a continuous cycle of improvement.

The conceptual framework of the study illustrated in Figure 1 below.

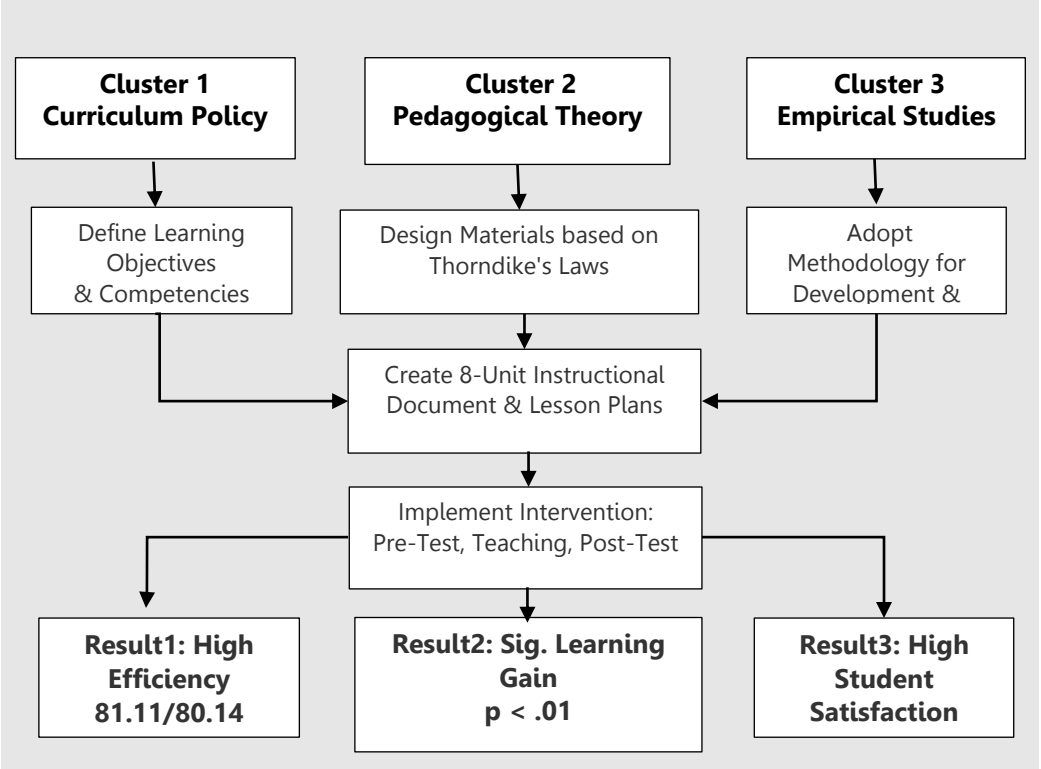

Figure 1 The Conceptual Framework

4. RESEARCH METHODOLOGIES

This study employs a quantitative research design, utilizing questionnaires as the primary data collection tool. The research methodology is outlined as follows:

4.1 Population and Sample

4.1. Population and Sample

The population for this study was first-year vocational certificate students enrolled at Pattani Technical College. A purposive sampling technique was employed to select a specific group that met the research criteria. The final sample consisted of 35 first-year students from the Electrical Power program who were enrolled in the compulsory course “English for Daily Life” (Code 20000-1201) during the first semester of the 2022 academic year. This intact group was selected as it represented the target demographic for whom the instructional materials were specifically designed.

4.2. Research Instruments

The study utilized four primary instruments, each developed and validated to ensure reliability and validity:

Instructional Document: An 8-unit instructional package was developed for the “English for Daily Life” course. The content and activities within each unit were explicitly designed around Thorndike’s three laws of learning: readiness, exercise, and effect.

Lesson Plans: A series of eight detailed lesson plans, corresponding to the instructional units, were created. These plans outlined 36 hours of structured instruction, integrating the instructional document and specifying learning objectives, activities, and assessments aligned with the theoretical framework.

Achievement Test: An 80-item multiple-choice test was constructed to measure learning achievement. The test's content validity was rigorously assessed by a panel of experts, yielding an Index of Item-Objective Congruence (IOC) ranging from 0.67 to 1.00 for all items. The test's reliability was confirmed through pilot testing, resulting in a high Cronbach's alpha coefficient of .913.

Satisfaction Questionnaire: A 10-item questionnaire using a 5-point Likert scale (ranging from 1 = lowest satisfaction to 5 = highest satisfaction) was developed to gauge students' perceptions of the instructional materials and learning process. Expert validation ensured content validity (IOC = 0.67-1.00), and its reliability was established with a Cronbach's alpha of .951.

4.3. Data Collection

The data collection procedure followed a sequential process to ensure consistency and minimize confounding variables:

Pretest Administration: Prior to the intervention, the 80-item achievement test was administered to all 35 participants to establish a baseline measure of their knowledge.

Intervention Implementation: The researcher conducted the teaching intervention over a designated period, delivering all 36 hours of instruction according to the developed lesson plans and utilizing the 8-unit instructional document as the core teaching material.

Posttest Administration: Immediately following the completion of the instructional intervention, the same 80-item achievement test was readministered to the participants to measure their learning achievement gains.

Satisfaction Survey: Subsequent to the posttest, the satisfaction questionnaire was distributed to all participants to collect data on their subjective experience and satisfaction with the instructional materials and the overall learning process.

4.4. Data Analysis

The collected data were analyzed using both descriptive and inferential statistical methods via statistical software packages. The analysis procedures were as follows:

Efficiency Analysis: The efficiency of the instructional materials (E1/E2) was calculated using established formulas. Process efficiency (E1) was derived from the average scores on all in-class activities and worksheets. Output efficiency (E2) was calculated from the average scores on the posttest. The benchmark for success was set at the standard 80/80 criterion.

Descriptive Statistics: Means (M) and standard deviations (SD) were computed to describe the central tendency and variability of the pretest scores, posttest scores, and satisfaction questionnaire responses.

Inferential Statistics: A dependent-samples (paired) *t*-test was conducted to compare the mean scores of the pretest and posttest. This analysis determined whether the observed improvement in learning achievement was statistically significant at the .01 level.

5. RESULTS AND DISCUSSIONS

This section presents the findings of the study on the efficiency of the instructional materials, the comparison of learning achievement, and the level of student satisfaction. The results are discussed in relation to the theoretical framework of Thorndike's Connectionism.

5.1 Efficiency of the Instructional Materials (E1/E2)

The efficiency of the instructional materials was evaluated against the standard benchmark of 80/80. The results, summarized in Table 3, demonstrate that the materials were highly effective.

Table 3: Efficiency Analysis of the Instructional Materials (N=35)

Efficiency Component	Full Score	Average Score	Percentage (%)
Process Efficiency (E1) **(Scores from worksheets & activities)**	80	64.89	**81.11**
Product Efficiency (E2) **(Scores from post-test)**	80	64.11	**80.14**
Overall Efficiency (E1/E2)			**81.11 / 80.14**

As shown in Table 3, the overall efficiency of the instructional materials was **81.11/80.14**, which exceeds the established benchmark of 80/80. This indicates that the materials were not only successful in facilitating the learning process (E1) but also effective in helping students achieve the intended learning outcomes (E2). The high process efficiency suggests that the in-class activities and worksheets were well-designed and appropriately challenging, leading to successful learning during the instructional phases.

5.2 Learning Achievement Comparison

A paired-sample t-test was conducted to compare students' learning achievement before and after using the instructional materials. The results, presented in Table 2, show a statistically significant improvement.

Table 4: Comparison of Pre-test and Post-test Scores for All Units (N=35)

Test	Full Score	Average Score ($\bar{X}$)	S.D.	t-value
Pre-test	80	25.37	5.00	
Post-test	80	64.89	4.62	**48.051***
Progress (%)			**49.40%**	

$p < .01$

The data in Table 4 reveals a substantial and statistically significant increase in the mean score from 25.37 (pre-test) to 64.89 (post-test), with a progress percentage of **49.40%**. The extremely high t-value ($t = 48.051$, $p < .01$) confirms that the improvement in students' achievement was not due to chance. This remarkable gain can be attributed to the structured and scaffolded learning activities within the instructional materials, which effectively addressed the students' needs and enhanced their understanding of real-life English applications.

5.3 Student Satisfaction Results

Student satisfaction was measured using a 5-point Likert scale questionnaire. The overall and individual item results are presented in Table 5.

Table 3: Student Satisfaction Levels Towards the Instructional Materials (N=35)

No.	Statement	Mean ($\bar{X}$)	S.D.	Level of Satisfaction
1.	Having the opportunity to know scores from worksheets or tests.	4.77	0.43	Highest
2.	The teacher's fairness in scoring each activity.	4.71	0.46	Highest
3.	The materials include images and vocabulary that aid understanding.	4.69	0.47	Highest
4.	The learning management increases enthusiasm for learning.	4.60	0.50	Highest
5.	The learning allows for exchanging opinions and knowledge with peers.	4.54	0.51	Highest
6.	The materials enable the use of IT to develop English skills.	4.46	0.61	High
7.	I practiced listening, speaking, reading, and writing until fluent.	4.40	0.65	High
8.	The materials improve listening, speaking, reading, writing, and comprehension.	4.34	0.59	High
9.	The tests in the materials encourage self-development.	4.34	0.59	High
10.	The handouts make it easy to understand principles of daily English.	4.26	0.66	High
	Overall Satisfaction	**4.51**	**0.45**	**Highest**

The overall satisfaction level was 4.51**,** which is in the “Highest” category. As detailed in Table 3, students were most satisfied with transparent evaluation (Items 1 & 2) and the visual aids within the materials (Item 3). The lowest satisfaction, though still "High," was with the clarity of the handouts (Item 10). This suggests that while the materials were highly effective and engaging, there is a minor opportunity to further improve the clarity and presentation of the informational content in the handouts.

5.4 Discussion in Relation to Thorndike’s Connectionism Theory

The design and implementation of the instructional materials were grounded in Thorndike's Connectionism Theory, which posits that learning is formed through associations between stimuli and responses, reinforced by readiness, exercise, and effect.

Law of Readiness: The materials were structured into clear, sequential units, preparing students mentally and motivationally for each lesson, which aligns with the high process efficiency (E1=81.11%).

Law of Exercise: The numerous worksheets, activities, and unit tests provided ample opportunity for repetition and practice, strengthening the correct language responses. This is directly reflected in the significant improvement in post-test scores.

Law of Effect: The immediate feedback from worksheets and tests (a key factor in student satisfaction) acted as positive reinforcement, making the learning experience satisfying and encouraging continued effort.

The results strongly support the application of Thorndike’s theory in this context. The significant learning gains **(**49.4% progress**)** and high student satisfaction **(**4.51/5.00**)** demonstrate that a learning environment designed with clear stimuli (lessons/activities), opportunities for response (practice), and positive reinforcement (feedback) is highly effective for teaching practical English skills in a vocational setting. The significant improvement in learning achievement and high student satisfaction supported the applicability of Thorndike’s

theory in vocational education contexts, particularly in skill-based subjects like practical English. The materials successfully created a learning environment where students could form and reinforce correct language responses through structured practice and positive outcomes.

6. CONCLUSION AND SUGGESTIONS

This study was driven by the need to develop effective instructional materials for the "Real-Life English" course within the vocational education curriculum. The conclusion summarizes the key contributions, acknowledges the study's limitations, and offers suggestions for future research.

6.1 Key Contribution

This study successfully synthesized three critical domains: it responded to the vocational curriculum's mandate for practical English skills by developing structured materials based on a solid pedagogical theory (Thorndike's Connectionism) and employed the proven empirical methodology of local efficacy studies. The results confirm that this integrated approach is highly effective.

The developed instructional materials not only met but exceeded the strict efficiency standards **(**E1/E2 = 81.11/80.14**),** demonstrating their quality and practicality. Their implementation resulted in significant and substantial learning gains (a 49.4% improvement, $p < .01$) across all eight thematic units, proving their effectiveness in enhancing students' practical English proficiency. Furthermore, the materials were received with a very high level of student satisfaction ($\bar{X} = 4.51$), particularly regarding transparent evaluation and engaging activities. This demonstrates that a theory-driven, well-structured approach can achieve both high learning outcomes and positive learner perceptions.

6.2 Limitations of the Study

The primary limitation lies in the study's research design. The use of a one-group pretest-posttest model without a parallel control group makes it difficult to definitively rule out the influence of external factors such as other simultaneous instruction, general maturation of the students, or the placebo effect of participating in a study on the observed improvement. While the magnitude of the learning gain is large and statistically significant, a controlled experimental design (e.g., a true experiment with a control group using traditional materials) would substantially strengthen the claim of causality, confirming that the improvement is attributable solely to the intervention of the new instructional materials.

6.3 Suggestions for Future Studies

Based on the findings and limitations of this research, the following directions for future studies are suggested:

First, employing a control group design - Future research should utilize a quasi-experimental or true experimental design with a control group to establish a more robust causal link between the instructional materials and the observed gains in learning achievement. Second, investigating long-term retention - A longitudinal study could be conducted to assess the long-term retention of the knowledge and skills acquired through these materials,

determining their lasting impact. Third, exploring broader application - The study could be replicated with different student populations (e.g., different vocational fields, different regions of Thailand) to test the generalizability of the materials and the pedagogical approach. Forth, incorporating qualitative methods - Future studies could include qualitative methods, such as interviews or focus groups, to gain deeper insights into the students' learning experiences and the reasons behind their high satisfaction, particularly to understand how the principles of Thorndike's theory (readiness, exercise, effect) were perceived in practice. Last, refining based on feedback - The slightly lower satisfaction score on the clarity of handouts (though still high) indicates an area for refinement. Future iterations of the materials could focus on enhancing the design and user-friendliness of the textual components.

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