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Investigating the Potential of Mixed Teaching Methods to Enhance Manufacturing Process Learning in Undergraduate Program

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Abstract. The learning process is essential for the development of learners. Especially for the students in need, focus on building skills consistent with future work. As the traditional method teaches a one-size-fits-all curriculum, mixed teaching methods are believed to be tailored to individual experiences and learning levels. The researcher has designed a hybrid teaching process incorporating Bloom's taxonomy to enhance learning efficiency. According to this taxonomy, personal learning occurs in three domains: cognitive, affective, and psychomotor. Despite having diverse learning backgrounds, individuals are expected to achieve similar learning outcomes, such as knowledge, understanding, and application. This study aimed to investigate the potential of mixed teaching methods and traditional learning methods to improve manufacturing process learning in undergraduate programs. The research was conducted with a quasi-experimental design with two sample groups (15 people per group), which compared the learning outcomes before and after the experiment and compared the experimental and control groups. The experimental group had a program to promote the mixed-learning process. To understand how welding parameters affected the quality of welding practice specimens, the emphasis on welding practice was combined with an analysis of the problems encountered during practice. Instructors asked questions to allow students to reflect and self-practice. The t-test analysis revealed that the learning outcomes of the experiment group showed a statistically significant improvement compared to the pre-experiment level, at the 0.05 significance level.

Keywords. traditional learning method, mixed teaching methods, Bloom's taxonomy, quasi-experimental design

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1. Introduction

Learning is an intellectual process (cognitive process) that causes humans to change in knowledge, perception, and skills that can be used to help solve life problems [1]. It is permanently caused by an activity that enhances peoples experiences, causing a person to compare new experiences with their preferences, which leads to the value of values, namely the reaction from society, and becomes a personality. The results of these learnings are sent to the brain to generate awareness and affect the person's behavior. Therefore, learning management must consider diversity in terms of knowledge base, learner experience, and potential access to new knowledge.

Effective learning management changes the brain and creates a pleasant learning environment that brings memorable experiences to the students. Therefore, learners who study happily will have good results in their studies and lives. This aligns with Bloom's concept, which believes that the learning process that comes with additional techniques and a good learning atmosphere from teachers will help create good learning for students. Although the learners have different knowledge and understanding backgrounds, their learning outcomes will be similar if they go through a good learning process. The concept of learning is divided into 3 main areas: 1) Cognitive learning is the kind of learning that involves intelligence, knowledge, thinking, the ability to think things through, and creativity. 2) Affective is the aspect of mind, values, feelings, gratitude, attitudes, and beliefs. 3) Psychomotor is the aspect related to the musculature and movement [2-5].

In this study, the researcher has applied Bloom's concept to EG101 Basic engineering practice, a primary subject in industrial engineering that focuses on welding practice to promote work in the manufacturing industry. This course is designed for first-year students taught in a traditional learning method, which focuses on lectures, for example, class summaries and assignments, known as passive learning. Although it enables students to attain basic industry knowledge, the passion for learning does not sway them, for learning will create suitable qualifications for future industrial engineers. Consideration of process safety, enhancement of diversity, and intellectual problem-solving skills is consistent with [6-7]. They have found a direct link between commitment and motivation in education, with education systems and learners creating meaning for learning and reducing study exhaustion. Therefore, the researchers added this mixed learning technique to the usual learning style to make engaging activities that stimulate learners' interest, enjoyment, and impression of what they are learning or new things.

As a researcher who is a full-time lecturer of such subjects, he noticed a limitation in the review or extension of the group of students. When studying at a higher level, there is a risk of forgetfulness, a limited connection between previous knowledge and new knowledge, and still being unable to apply the practice of how to solve problems in the industrial production process. Therefore, the researcher has developed an integrated technique interm of the engineering knowledge conbinded with engineering content with thinking and design processes to enhance the skills and intelligence that are considered the basic competencies of an innovator or engineer, consistent with Busayanon [1]. They noted this connection of the learning that creates happiness in the learner and affects the mood of the brain individual. Factors influencing behavior are enthusiasm and interested in finding out more fun ways to learn. The power to train oneself to learn to solve problems that arise in life. The mixed learning technique was developed and used to experiment with the first-year undergraduate students of the Faculty of Engineering to study learning behavior according to Bloom's concepts of satisfaction and knowledge assessment.

The experiment was divided into two groups: a control group that received conventional instruction and an experimental group that received integrated techniques in the course using the same content as the control group. The results of this study can be used as a guideline for developing the teaching and learning process for the study group, especially in the practical subjects, to create more effective learning behaviors.

The aim of this research is to study the potential of Mixed Teaching Methods in promoting the learning process among undergraduate students. The hypothesis of this research are: 1) After the experiment, the students in the experimental group had cognitive, affective, and psychomotor learning behaviors. They were satisfied with the learning process and had higher knowledge than the control group students. 2) After the experiment, the students in the experimental group had cognitive, affective, and psychomotor learning behaviors with satisfaction with the learning process and had higher knowledge than before the experiment.

2. Review Literature

Bloom's Taxonomy

Based on Bloom's theory of learning [4], organizing learning for learners focuses on managing the process of creating knowledge and instructor's techniques combined with creating a learning environment. Although learners have different cognitive backgrounds, Bloom's taxonomy believes that a good learning process can lead to similar learning outcomes. A successful teaching and learning process allows students to learn, and the transition from old to new behaviors is relatively permanent. This new behavior results from experience or practice in the learning management process, and these behaviors are not spontaneous due to age changes, intuition, or coincidence.

The critical factor that makes the learning process successful is that the teacher has a goal. According to Bloom's Taxonomy learning outcomes will occur in three areas: the cognitive domain, the affective domain, and the psychomotor domain, which was revised to be consistent with learning behavior. The cognitive learning behavior still needs to improve in the overlap of the definition and meaning at each level of behavior. In 2001, [5] revised Buddhist teaching behavior and "Bloom's Revised Taxonomy." As a result, in this study, Bloom's Revised Taxonomy was used to measure the cognitive level, which describes learning behavior in each area and sub-level as follows, based on the revised principle of developing students' learning behaviors as follows:

Cognitive Domain

It is a learning behavior related to intelligence, knowledge, thoughts, and intelligence. The ability to think creatively, believing that if one learns and builds more frequent experiences or practices, brain processes work more efficiently. Able to remember well, understand, and apply knowledge to solve basic and complex problems better.

Affective Domain

Psychological behavior includes values, feelings, impressions, attitudes, beliefs, interests, and virtues. This type of learning occurs when a person learns something new and then makes sense of it. Have an interest, believe, perceive, or feel good about this learning style and be willing to join or respond to it. There is an adjustment of what is learned in the self until it becomes a value to form one's own identity or personality, which is a personal habit.

Psychomotor Domain

The psychomotor domain is an activity-related behavior characterized by a dominant range of skills, such as the quality of work delivered on time. The psychomotor domain is the fusion of knowledge, ideas, understandings, values, and skillful execution.

3. Scope of Study

Methodology

This study was a quasi-experimental design, two-group pretest, and posttest (Pretest Posttest Static Group Comparison Design). The researcher has developed a model for teaching and learning in mixed learning and applied it to experiments with 30 undergraduate students from the Faculty of Engineering. The experiment was divided into Experimental and Control groups with 15 students. The sampling method was random sampling by drawing lots according to student ID numbers to separate groups. The experimental group received mixed learning methods, while the control group received traditional learning methods. The researcher randomly assigned EG101 students from the same department and asked the subjects to assess their pre-learning knowledge with the pre-experimental questionnaire assessment. Post-test knowledge assessment took place immediately after the end of the experiment in conjunction with post-test questionnaires. Learning lesson in each group uses the same content within 1 month, 4 times, 3 hours each time, 12 hours, with the same instructor, but using different teaching techniques.

Research Instrument

1. There were 2 sets of tools used to collect data, namely, Bloom's learning behavior assessment scale and the Learning Process Satisfaction Scale. This assessment is a rating scale of five levels (5 being the highest and 1 being the lowest). Three experts evaluated this questionnaire: 1) experts from the Institute of Skill Development, 2) experts in industrial processes, and 3) experts in behavioral science. The expert evaluation results found a value higher than 0.50 for 38 items with a confidence value of 0.90. A knowledge assessment test of 10 items, consisting of 4 options, was also assessed by 3 experts with a confidence value higher than 0.60.

2. Learning lesson in each group uses the same content (with the same instructor in difference teaching and learning method) and within 1 month, 4 times, 3 hours each time, totaling 12 hours. The learning contents are divided into 4 topics: 1) Basic knowledge of welding processes, 2) Basic welding practice, 3) Advanced welding skills practice, and 4) Discussion to learn with enterprises. The control group was taught in a traditional learning method: lectures and examples of situations/tools through illustrations and online media. The experimental group is conducted in an active learning method that allows students to participate in all activities. The instructor uses a narrative approach while encouraging learners to understand, perceive and assimilate the content into real life in their work. Instructors use lectures with thought-provoking questions and solutions

with successful examples to solve problems in actual production processes. Then with bringing distinct types of tools to the students in the experimental group to practice. Instructors allow students to present their opinions on applications and methods to solve problems and listen to differences and similar experiences for group discussions. Instructors summarize the knowledge gained from each lesson to create crystallization. While the control group uses traditional teaching methods, emphasizing lectures during class, giving opportunities to ask questions, and bringing examples of problem situations and solutions in the production process. The differences between traditional teaching and mixed teaching are shown in Table 1.

Table 1. The differences between traditional teaching and mixed teaching.

Bloom's Taxonomy	Traditional teaching	Mixed teaching
Cognitive Changes in cognition, understanding, and thinking lead to changes in the brain and a greater connection to reality.	- Teaching lectures and giving examples of using the tools in real places through learning media such as YouTube, etc. - Inquiring about students' understanding after each lecture	- Give examples of welding machines and welding equipment used in industry. - Use a game where students pick up case study flashcards to predict situations arising from welding machines and equipment. -Active learning allows students to participate in all activities, along with stimulating questions, alternating lectures, and assessing understanding with the learners at all times. -Brainstorming activities to create mind-mapping diagrams of manufacturing processes related to welding in industrial processes. Along with showing the points that are often a problem, identifying the cause of the problem, finding concrete solutions, having a high probability in terms of speed, being cost-effective and sustainable, etc.
Affective Changes in learning new things that make learners feel mental, belief, and interest, such as touching the welding equipment by themself, creating confidence and feeling good about the learning received, etc.	- Explain the importance of welding practice to future careers. - Give an example of future labor market demand.	- Begin by asking students about their interest or curiosity about additional content and their motivations for learning the subject to create a shared understanding and perception between the instructor and learners. - Instructors inquired about their feelings towards themselves, their profession, and their attitudes toward the industrial production process after teaching. - The teacher assigns the task of writing a self-report on future work expectations and presenting it to the entrepreneurs in the 4th period (students meet entrepreneurs).
Psychomotor Individual personal changes result in learning about thoughts, understandings, feelings, values, and interests. Apply what you have learned to practice until you become more proficient, such as using your hands to weld more proficiently, etc.	- Explain objectives and evaluation criteria. - Let students practice and assign work.	- Instructor demonstrates to show as an example. - Allow some students to participate voluntarily in advanced welding practice and convey this to their peers. - Bring industrial problems that occurred in the production process to practice with students by using learning materials from industrial damaged workpieces from the industry.

5. Results

Analysis: Descriptive statistical analysis was used to analyze the results by using a five point rating scales, including mean, standard deviation, and independent sample t-test between the control and experimental groups. Paired Sample t-test analysis was used to analyze the level of learning behavior and satisfaction with the learning process before the experiment (Pre-test) and post-test (Post-test). The criteria for evaluating the average are divided into 1)1.00-1.18 points is the lowest level. 2) 1.81-2.60 points, at a low level. 3) 2.61-3.40 points in moderate level. 4) 3.41-4.20 points, at a high level. and 5) 4.21-5.00 points, in the highest level.

A total of 30 subjects participated in this study, divided into 15 experimental groups and 15 control groups. Twenty males (66.7%) and 10 females (33.3%) were first-year Faculty of Engineering undergraduate students.

According to the first hypothesis, the mean analysis results of overall learning behavior after learning of the control group were at a low level ($\bar{x}$ = 1.99, S.D. = 0.15). The experimental group's mean after the experiment was at a high level ($\bar{x}$ = 3.77, S.D. = 0.48). When tested by independent t-test, it was found that after the investigation, the experimental group had higher learning behavior than the control group at a statistically significant .05 level. Considering the Affective Domain, there was a statistically significant difference between the groups at the .001 level, which can be summarized in Table 2.

Table 2. Compares learning behavior between groups.

Bloom's Taxonomy	$\bar{X}$	Interpretation	S.D.	Mean Difference	t-test
1. Cognitive Domain					
Control Group	2.08	low	.40	1.659	10.58
Experimental Group	3.74	high	.45		
2. Affective Domain					
Control Group	2.05	low	.22	2.008	11.98**
Experimental Group	4.06	high	.60		
3. Psychomotor Domain					
Control Group	1.88	low	.34	1.552	8.064
Experimental Group	3.43	high	.66		

* statistically significant difference at the .05 level.

** statistically significant difference at the .001 level

Table 3. Comparison of learning behavior levels before and after the experiment. (experiment group).

Bloom's Taxonomy	$\bar{X}$	Interpretation	S.D.	t-test	p-value
Pre-test	3.13	moderate	.40	4.76	<.001**
Post-test	3.74	high	.48		
1. Cognitive Domain					
Pre-test	2.82	moderate	.51	6.28	<.001**
Post-test	3.74	high	.45		
2. Affective Domain					
Control Group	3.75	high	.39	1.58	.136
Experimental Group	4.06	high	.60		
3. Psychomotor Domain					
Control Group	2.81	moderate	.64	2.679	.018*
Experimental Group	3.43	high	.66		

* statistically significant difference at the .05 level.

** statistically significant difference at the .001 level

From the second hypothesis, the results of the analysis of learning behaviors before and after the experiment in the experimental group were significantly different at the .001 level. The mean learning behavior before the experiment was moderate ($\bar{x}$ = 3.13, S.D. = 0.40). After the experiment, it was found that the subjects had high learning behaviors at a high level ($\bar{x}$ = 3.74, S.D. = 0.48). The cognitive domain had a statistically significant increase in the mean level at .001, the pre-test mean was moderate ($\bar{x}$ = 2.82, S.D. = 0.51), and the post-test had a high level of learning behavior scores. ($\bar{x}$ = 3.74, S.D. = 0.45). The affective domain found no statistically significant difference; pre-test behavior was high ($\bar{x}$ = 3.75, S.D. = 0.39), and post-test learning behavior was high ($\bar{x}$ = 4.06, S.D. = 0.60). The Psychomotor domain had a statistically significant increase in the mean level at .001, with the pre-test mean being moderate ($\bar{x}$ = 2.81, S.D. = 0.64) and the post-test having learning behavior scores at a High level ($\bar{x}$ = 3.43, S.D. = 0.66), which can be summarized in Table 3.

Table 4. Comparison of satisfaction with the learning process and knowledge scores before and after the experiment. (experiment group).

Before and After comparison results	$\bar{X}$	Interpretation	S.D.	t-test	p-value
Satisfaction with the learning process					
before the experiment	3.40	moderate	0.35	2.71	0.017*
after the experiment	3.80	high	0.52		
Level of knowledge					
before the experiment	5.40/10	moderate	1.29	10.856	<.001**
after the experiment	9.63/10	high	0.39		

* statistically significant difference at the .05 level.
** statistically significant difference at the .001 level

The level of satisfaction with the learning process was significantly increased at the .05 level. The satisfaction level before the experiment was moderate ($\bar{x}$ = 3.40, S.D. = 0.35) and high after the experiment ($\bar{x}$ = 3.80, S.D. = 0.52). The learning scores of the experimental groups were significantly different at the .001 level. The knowledge scores before the experiment were moderate ($\bar{x}$ = 5.40/10, S.D. = 1.29) and increased to high depending on the high level after the investigation ($\bar{x}$ = 9.63/10, S.D. = 0.39), which can be summarized in Table 4.

The analysis results indicate that:

1. The experimental group that received the combined supplementary technique instruction was different from the control group that received regular instruction at the statistical significance level of .05. When considering each side, it was found that the mean level of learning behavior in the affective domain was significantly different at the .001 level. The level of satisfaction with the learning process was significantly different at the .05 level, and the knowledge scores were significantly different between the experimental and control groups at the .05 level.
2. The results of the statistical analysis of the experimental group reinforced with integrated techniques showed that the level of post-experimental learning behavior increased significantly at the .05 level. When considering each domain, it was found that there was a statistically significant increase in the cognitive and psychomotor domains, related to a statistically significant increase in satisfaction and knowledge scores.

6. Discussion

The results of the data analysis showed that the experimental group receiving mixed instruction was statistically significantly different from the control group. This indicates that receiving the integrated reinforcement technique increased the students' learning level compared to those who did not receive the method. When considering each domain, it was found that the aspect that was statistically significantly different was the affective domain aspect, which was the aspect of changing thoughts, perceptions, minds, and attention.

Therefore, it can be seen that using techniques to alternate thinking, practice, and knowledge enhancement periodically. It is a confidence-building process. At the same time, such teaching helps to draw attention to knowledge exchange from one expert to another. To develop a learning process at work, for example, giving examples of work problems that have occurred in the past, examples of successful work improvements that see good results, etc. This model is primarily on-the-job or on-the-job training (On Job Training). Nakprasong, Thaping, and Rukijkanpanit [8] found that training helped to reduce errors on the job, and the waste in the factory decreased from 48.3% to 11.7%.

This research showed that the experimental group improved overall learning behavior after receiving the integrated technique. When considering each domain, it was found that learning levels in the cognitive and psychomotor domains increased statistically significantly. Satisfaction and knowledge scores increased statistically significantly because the researcher added a variety of techniques to promote knowledge, thinking, and skills through Active Learning and Collaborative Learning. These methods use collaboration as a group process to create mutual benefits, where learning in this style improves critical thinking skills. This is consistent with research that found that cooperative learning enhances critical thinking skills and achieves a statistically significant higher achievement than before learning at the .05 level [9-10].

Managing learning with different techniques positively stimulates learners' enthusiasm, especially when it's a practical subject. It is consistent with Bloom's learning theory development techniques as it allows children to engage with brainstorming interactively or collaboratively rather than competitively.

Learners can build a body of knowledge and organize a learning system by acquiring knowledge from actual experiences. In this way, the instructor should be the facilitator of learning management so that the learners can think for themselves and act independently [11]. Instructional media that come to support that students can choose to study knowledge without restrictions on place or time [12]. However, the learning ability or development of the learner may require continuous study time, and the individual's learning ability is also dependent on experience before the trial. As in the research of [13] used self-created video lectures and online teaching video clips from social media. The study results revealed that the learners' achievement was significantly higher than the 60 percent criterion at the level of .05 at the level of knowledge and memory. However, in terms of application, learning achievement was still lower than the standard.

Therefore, this research creates a body of knowledge in teaching and learning to engineer students about the primary production process. Emphasis on learning about welding is the basis of practical subjects and expertise applied in the industrial production process. The study found that supplementary blended learning techniques produce changes in knowledge, perception, comprehension, and analytical and practical skills, creating satisfaction and increasing knowledge for learners better than traditional learning methods. Techniques that make changes must be flexible techniques that adapt to the atmosphere of teaching and learning and meet with real entrepreneurs. Students are eager to understand the context of problems and working conditions and see the practical process's importance during their university learning. The integrated techniques used by the researcher consisted of 1) examples, 2) games, 3) participatory alternating thought-provoking questions, 4) brainstorming that emphasized cooperative learning, 5) Understanding students before starting activities, and 6) Giving advice from experts and practicing experiences from real problems in the industry.

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