DEVELOPMENT OF A LEARNING MODEL FOR BLENDED COLLABORATIVE KNOWLEDGE CONSTRUCTION IN VOCATIONAL EDUCATION

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ABSTRACT

Modern education has been evolving based on a growing demand for innovative instructional approaches to serve diverse learning needs. This doctoral research endeavored to meet this demand by developing a "Blended Collaborative Knowledge Construction Learning Model" tailored for vocational education. This model was a combination of blended learning, collaborative learning, and knowledge construction to create an impactful and engaging learning experience for vocational students.

The purpose of this research was to create a learning model that effectively integrated both traditional classroom settings and digital learning platforms. The research samples consisted of 30 students from two distinct classes at Zigong Vocational Training College, ensuring a comprehensive understanding of the model's applicability. By employing the rigorous Delphi method, this study gathered insights from experts in the field, providing a solid foundation for the development of the proposed learning model. The research findings revealed that the proportion of students who enhanced self-directed learning capabilities, elevated collaboration skills, and improved creative problem-solving abilities was significantly higher than those who engaged with the "Blended Collaborative Knowledge Construction Learning Model".

The results of this study had significant implications for vocational education. The developed model not only equipped students with theoretical knowledge but also bridged the gap between theory and practical application, which was crucial in vocational fields. The innovative approach allowed students to take charge of their learning process, nurture collaborative skills, and foster a deeper understanding of the subject matter. The findings of this research were useful for educators, institutions, and policymakers in vocational education. By displaying the potential of this innovative learning model, this study provided a framework that could be adapted and adopted to enhance vocational education methodologies. As the educational field continued evolving, the insights gained from this research offered a promising avenue to redefine the learning experience and prepare vocational students to be successful in their chosen fields.

Keywords: learning model, blended learning, collaborative learning, knowledge construction, Delphi method, vocational education

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List of Abbreviations

TECL	Technology-enhanced Collaborative Learning
CSCL	Computer Supported Collaborative Learning
BCL	Blended Collaborative Learning
RCTs	Randomized Clinical Trials
GCC	Gagné, Constructivism, and Constructionism
SD	Standard Deviation
RMUTT	Rajamangla University of Technology Thanyaburi
WBI	Web-based Instruction
CAI	Computer-assisted Instruction
IQR	Interquartile Range
IOC	Item Objectives Congruence
BCKC	Blended Collaborative Knowledge Construction
SRCK	Self-Regulated Content Knowledge
BCLCK	Blended Collaborative Learning Content Knowledge
VECK	Vocational Education Content Knowledge

CHAPTER 1

INTRODUCTION

This chapter focused on describing the background of the research, research purposes and problems, research theoretical framework, etc.

1.1 Background and Statement of the Problem
1.2 Significance of the Study
1.3 Purpose of the Study
1.4 Research Questions
1.5 Research Framework
1.6 Theoretical Perspective
1.7 Definition Perspective
1.8 Expected Benefits

1.1 Background and Statement of the Problem

1.1.1 The dual drive of information technology promotes continuous transformation in teaching and learning

The incorporation of information technology and education has consistently advanced through four stages during global educational practice, with the ongoing advancement of educational informatization: initiation, application, integration, and innovation(Kumar et al., 2021). Disruptive developments have also occurred in education's delivery system. The primary objective of educational informatization is to achieve the transformation of information technology in teaching and learning(Yan 闫守轩 & Yang 杨运, 2021). The way that information technology is changing education and learning is also changing educational forms and modernizing education. Information technology not only transforms students' "learning" in terms of their knowledge and ability structure (training objectives), learning methods, and learning support systems but also innovates teachers' "teaching" in terms of their abilities and roles, teaching models, curriculum structure, etc(Caena & Redecker, 2019).

1.1.2 Blended learning has become an important trend in curriculum design and reform

Since its inception as a learning method at the turn of the century, blended learning has received much study and application. Its meaning has also continued to grow as technology and learning science have advanced. Its distinctive feature is that it makes the most of the benefits of in-person instruction and different learning support technology(Cleveland-Innes & Wilton, 2018). In the world of education, blended learning is widely acknowledged to increase learning effectiveness(Dziuban et al., 2018; Garrison & Kanuka, 2004; Hussein Al Noursi, 2020; Medina, 2018). Prior research has demonstrated that blended learning with a focus on good design can significantly enhance students' academic achievement, involvement, community awareness, contentment with their learning environment, and effectiveness of collaboration(Nortvig et al., 2018; So & Brush, 2008). The US Department of Education noted that, when compared to online and face-to-face learning, blended learning is the most effective way to raise students' academic performance a survey report titled "Evaluation of Evidence-based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies" that was published in 2009(Nagel,

2009). Additionally, blended learning has been cited as a key trend in promoting the use of higher education technology for six years from 2012 to 2017 in the New Media Alliance of the United States Horizon Report (Higher Education Edition), which considers it to be a more advanced form of online learning(Becker et al., 2017; Alexander et al., 2019). In China, blended learning is also a common expectation. A researcher surveyed instructors around the country in 2017 on "the most ideal teaching method in your mind for the future" and received over a thousand responses. Chinese teachers now view "blended teaching," which combines online learning and offline discussion, as the most effective form of instruction going forward(Wang, 2022). Blended learning is now being used by more and more schools to rethink the physics learning environment and enhance student engagement, making it one of the key trends in curriculum redesign and reform research.

1.1.3 Collaboration becomes the core way of knowledge construction

Today, collaborative learning is a teaching technique and method that is well-acknowledged in the area of educational research and widely adopted by schools(Pozzi et al., 2023). With the advancement of information technology, technology-enhanced collaborative learning (TECL) in particular is continuously updated. Collaboration has been shown to increase students' academic performance when used as a learning approach, and it is also acknowledged as one of the essential abilities that students should have in order to succeed in the 21st century(Limna et al., 2021). Students become the main source of collaborative knowledge construction as a result of collaborative interaction, which must ensure role equality and situation symmetry(Bouton et al., 2021). Teachers serve as designers and guides, providing resources, methods, and other forms of support for students(Rapanta et al., 2020), which is also consistent with the trend of student-centered education reform.

Using technology as a medium has become a crucial factor affecting the process of cooperative knowledge construction due to the ongoing development of information technology and its growing integration with education. The central concept of collaborative knowledge-building research and practice since the late 1990s is TECL, exemplified through Computer Supported Collaborative Learning (CSCL)(Suthers, 2021). As a result of the integration of learning and technology, influential new learning theories like the theory of online collaborative learning, the theory of group cognitive interaction, and the theoretical model of inquiry community have been created and developed. Additionally, researchers have studied the variables influencing the effectiveness of collaborative roles and learning interventions in the CSCL process, the value of teacher guidance verification, and the development of tec(Mi et al., 2023). According to the group cognition idea, group cognition can help students build knowledge more effectively than individual cognition, and technology like computer networks can be useful collaboration tools in group cognition. It is also highlighted that the collaborative knowledge production in CSCL occurs through student interaction and is based on resources in the dialogue environment rather than being the outcome of information processing in each student's mind(Kaliisa et al., 2022; Ludvigsen & Steier, 2019).

1.1.4 Blended collaborative learning becomes a new paradigm of technology and curriculum integration

By integrating the positive aspects of online and in-person instruction, blended collaborative learning (BCL) refers to the provision of teachers and students with a setting and strategic support for cooperative knowledge building. In 2002, British professor Prendergast arranged an online course where the idea of BCL was first put up and explored. In the beginning, it was an enhanced kind of distant learning, similar to blended learning. A new learning form and strategy for integrating technology and curriculum, online and offline collaboration, its concept and connotation have been significantly expanded with ongoing research and practice, including not only the mixing of collaborative environments but also the mixing of collaborative technologies/tools, and collaborative strategies/methods. The integration of blended learning and collaborative learning is seen as a development trend for higher education in the future, according to the 2014 Horizon Report (Higher Education Edition)(Johnson et al., 2014).

By enhancing effective collaboration and encouraging students' independent inquiry and in-depth understanding, BCL aims to maximize the benefits of the combination of CSCL and surface collaborative learning and to improve the impact of knowledge construction.

1.2 Significance of the Study

The research focuses on the following:

1.2.1 Encourage the theory of blended, collaborative learning to develop and improve. Based on prior research, this study makes an effort to define the term BCL and defines it as a new learning format that successfully incorporates technologically enhanced collaborative learning into mixed-mode teaching environments. The fundamental idea of collaborative knowledge building is merged to create a blended collaborative knowledge construction activity model with a cogent theory and unified logic on the basis of summarizing, analyzing, and improving BCL theory and practice. In addition to answering the question of how BCL optimizes the process of student collaborative knowledge construction, this will serve as a foundation for an analysis of the process and mechanism of collaborative knowledge construction in the BCL environment.

1.2.2 Encourage the use and dissemination of mixed collaborative learning strategies. This study intends to advance efficient teamwork and improve the efficiency of knowledge creation. A blended collaborative knowledge construction activity model is created to direct the design and implementation of BCL activities by integrating context, aims, assessment, and processes from BCL theory and practice. This will support the integration of resources and technology, the design of scenarios and roles, and the development of strategy systems in the BCL practice process, improving the effect of learners' collaborative knowledge construction in the BCL process and fostering the use and promotion of BCL practice.

1.3 Purpose of the Study

The objectives of the study are as follows:

1.3.1. To synthesize learning process theories related to blended collaborative knowledge construction in vocational education;

1.3.2 To identify and develop a Learning model using learning process theories for blended collaborative knowledge construction in vocational education.

1.4 Research Questions

1.4.1 How to build a blended collaborative knowledge construction learning model?

1.4.2 How does blended collaborative learning promote the effect of collaborative knowledge construction?

1.5 Research Framework

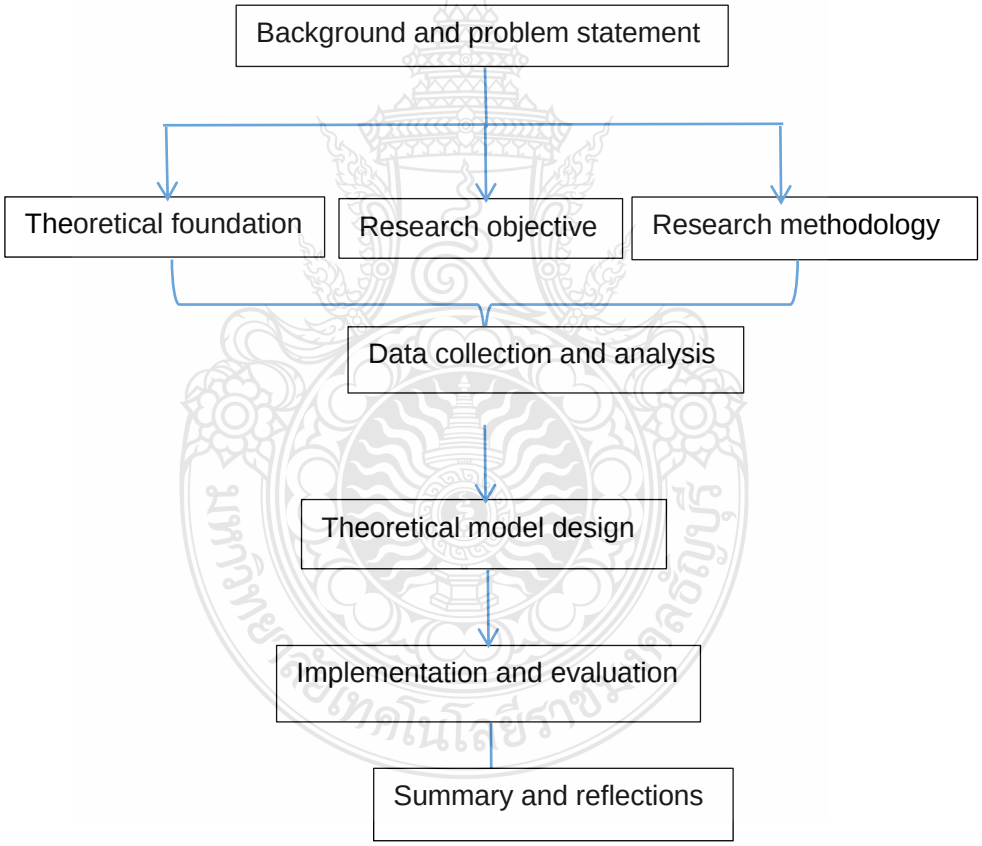

Figure 1.1 Research framework of blended collaborative knowledge construction learning mode.

1.6 Theoretical Perspective

1.6.1 Instructional Model of Learning Process Theories is defined on the basis of selected psychology theories of Gagné's theory, constructivism, and constructionism. There are analyses in principles, teaching and learning, activities and strategies, environments, and learning models. The purpose of this study is to synthesize Constructivism and Constructionism psychological theories and propose a new learning model.

1.6.2 The four terms Principles, Teaching/Learning Activities/Strategies, Teaching Learning Environments, and Teaching Learning Models are the emphasis of the theoretical viewpoints of the review of these theories.

1.6.3 The Delphi technique was used to synthesize a Learning Model of blended Collaborative Knowledge Construction in vocational education. They all had a doctoral degree and had worked for over five years at least in the position of Assistant Professor.

1.7 Definition Perspective

1.7.1 The linked process theory of a complete blended collaboration knowledge construction learning model and how to create a blended collaborative knowledge construction learning model to support the improvement of the learning effect are the main research areas of this study.

1.7.2 The methods used in this study are as follows:

1.7.2.1 Subjects: The samples of this study were 30 students in two classes of the same grade and the same major in the second semester of the academic year 2022-2023 in Zigong Vocational and Technical College.

1. 7.2.2 The research instruments consisted of (1) Experimental and control group performance data. (2) Learning Satisfaction Survey Questionnaire.

1.7.2.3 The data were analyzed using *Mean*, Standard Deviation, and *t-test*.

1.7.2.4 The content is a basic course in computer application.

1.7.2.5 For data collection, the researchers divided two classes of vocational education students into an experimental group and a control group for the experiment. The experimental data of the two groups of students are collected, and the data are statistically related to the mean value, standard definition, and t test. Statistical data after the experiment, calculate the average (x) of (O1) and (O2), and compare.

1. 7.2.6 Data analysis: Statistics used to analyze data. Compare the academic performance of the students in the experimental group and the control group.

1. 7.2.7 Evaluate the satisfaction of students in the blended collaborative knowledge construction learning model through standard definitions.

1.7.3 Definition of Key Terms

The key terms involved in this study are learning models, blended collaboration, knowledge construction, and vocational education.

1. 7. 3.1 Learning Mode refers to a way or method that people adopt when carrying out learning activities. Different learning models are suitable for different learning objectives and individual differences of learners(Peng & Chen, 2019). Common learning models include but are not limited to the following:

1）Traditional learning mode: also known as the teaching mode, learners acquire knowledge by participating in classroom teaching, listening to lectures, and reading textbooks. This model focuses on teacher-student interaction and knowledge transfer(Scrivener, 2005).

2）Distance learning mode: Learners can learn through remote channels such as the Internet, video conferencing, and television, without being limited by time and place. The distance learning model is suitable for learners who are unable to attend traditional face-to-face courses(Bates, 2005).

3）Self-directed learning mode: learners complete learning tasks independently by planning and managing the learning process by themselves, choosing appropriate learning resources and learning methods(Loyens et al., 2008). The autonomous learning model focuses on cultivating learners' autonomy and problem-solving ability.

4）Collaborative learning model: learners jointly build knowledge by collaborating, discussing and sharing learning experiences with others(Peters & Armstrong, 1998). Collaborative learning mode focuses on the interaction between learners and the cultivation of cooperation ability.

The selection of a suitable learning mode should be based on comprehensive consideration of factors such as learning objectives, subject characteristics, individual differences of learners, and learning environment. Different learning modes can be combined and converted to meet the different needs of learners and the requirements of learning tasks.

1.7.3.2 Blended Collaboration refers to the combination of different working models and technical means, enabling team members to collaborate at different times, places and ways(Islam et al., 2022; Kaur, 2013). It adopts a combination of online and offline methods, making full use of digital technology and cloud platforms to enable team members to cooperate more flexibly. Blended collaboration is a flexible and efficient working mode that can improve the team's collaboration efficiency and innovation ability. With proper technical support and communication management, the advantages of hybrid collaboration can be fully utilized to achieve better work results.

1.7.3.3 Knowledge Construction refers to the process in which individuals gradually form their own knowledge system and cognitive structure through interaction with the outside world and accumulation of experience(Baanqud et al., 2020; Bouton et al., 2021b). In knowledge construction, individuals perceive, understand, and integrate external information through active exploration, observation, and practice, and then transform it into their own knowledge and understanding. This process involves cognitive activities such as individual perception, memory, thinking, reasoning, and judgment. The core theory of knowledge construction is constructivism theory, which holds that knowledge is not passively received, but acquired through the active participation of individuals. In the process of knowledge construction, the interaction between the individual and the environment plays an important role. Individuals constantly construct and adjust their own knowledge structure through communication and dialogue with others, as well as interaction and practice with the environment. In the field of education, knowledge construction theory has greatly influenced teaching and learning(Ahmad et al., 2020). The teaching method based on knowledge construction theory focuses on students' active participation and cooperative learning, emphasizes students' inquiry and discovery, and encourages students to construct knowledge in practice. This teaching method can promote the development of deep understanding and thinking ability of students.

1.7.3.4 Vocational Education refers to a form of education that trains talents with specific vocational skills and knowledge to meet the needs of social development and the labor market(Mutohhari et al., 2021; Li & Pilz, 2023). Vocational Education refers to teaching both theory and practice; instructors create operations for conditional learning; and learners create learning by doing which can lead to self-discovery. It aims to equip students with the professional skills and practical experience required for employment by providing practical training and education. Vocational education can include different levels and forms, such as vocational high schools, vocational-technical colleges, vocational training institutions, etc. It is usually distinguished from academic education (such as undergraduate education), focusing on the development of practical skills and professionalism. The object of this study is mainly for vocational and technical colleges.

1.7.4 The following is a list of limitations of this study:

1.7.4.1 A specific number of experts, qualified in educational psychology from the same university determined the results. They all had worked for over five years at least as Assistant Professors.

1.7.4.2 The results and interpretations reflect the bias of the analyst.

1.7.4.3 Communication was face-to-face or by post, and the questionnaire was handed to all experts on their appointment.

1.7.4.4 The sample size of this study was small. Due to practical reasons, the participants in this study were students in two classes of vocational-technical schools. The cultural background information of the sample was relatively single, and there was a lack of diversified investigations in terms of professional background, education level, age, and region. culture), gender, etc.

1.7.5 The scope of this study is divided into two phases:

Phase I: To synthesize learning process theories related to blended Collaborative Knowledge Construction in Vocational Education.

1） The participants chosen for this study consisted of 17 experts who were chosen through the purposive sampling method. Experts were qualified in educational psychology, educational technology, computer science and technology. They all had a doctoral degree and had worked for over five years, and at least in Associate Professor's position.

2）This study was to synthesize the theories of Gagné, Constructivism, Constructionism, and Blended collaborative learning.

3）The theoretical perspectives of the review of these theories focus on four terms, namely: Principles, Teaching/learning activities/strategies, Teaching learning environments, and Teaching learning models.

Phase II: To identify and develop an instructional model based on a blended collaborative knowledge construction learning mode in vocational education.

1） The participants of this study include 100 teachers from multiple universities and vocational colleges in China, who have excellent professional skills in computer science and technology, and vocational education.

2）The survey and participatory observation were used for the identification and development of an instructional model of learning process theories for blended

collaborative knowledge construction learning mode in vocational education in vocational education.

1.8 Expected Benefits

The expected benefits are as follows:

1.8.1 This study provides an understanding of the learning process theory related to blended collaborative knowledge construction in vocational education.

1.8.2 This study contributes to the identification and development of learning models for blended collaborative knowledge construction in vocational education in Sichuan Province, China.

CHAPTER 2
REVIEW OF THE LITERATURE

This chapter focused on reviewing the previous studies related to the following area relevant to this research.

2.1 Theoretical Perspectives of Learning Processes
2.2 Blended Learning in Vocational Education
2.3 Collaborative Learning Strategies
2.4 Knowledge Construction in Blended Learning
2.5 The Delphi technique
2.6 Literature Review of Relevance of Research
2.7 Literature review summarization

2.1 Theoretical Perspectives of Learning Processes

Gagné's theory(Smith & Ragan, 1996), constructivism theory(Bada & Olusegun, 2015; Fosnot, 2013), constructism theory(Baviskar et al., 2009), mental processes(Monsell, 2021), learning by doing(Anzai & Simon, 1979), and social context(Siegel, 2003)are the six theoretical perspectives that are the focus of this review.

Though Piaget and Gagné focused on mental processes, learning by doing, and social context, constructivism, constructionism, and constructivism are all psychological theories that aim to aid learners in achieving learning objectives effectively and efficiently(Koschmann, 2012). In this way, it could be argued that they adhere to Section 24 of the Office of National Education Act, which states that "In organizing the learning process, educational institutions and agencies concerned shall provide training in thinking process, management, how to face various situations, and application of knowledge for obviating and solving problems" (Office of National Education Commission, (Commission & Others, 1999)). This seeks to equip students with the skills they need to advance personally and compete in the global knowledge-based economy. The Office of National Education Commission, 1999, section 66 further states that "learners shall have the right to develop their capabilities for utilization of technologies for education as soon as feasible so that they shall have sufficient knowledge and skills in using these technologies for acquiring knowledge for themselves on a continual lifelong basis." This attempts to prepare students to use technology to pursue knowledge.

2.1.1 Gagné's Theory

"Conditions of learning" is a notion in Gagné's theory. It describes many forms or levels of learning. There are nine instructional events that serve as the foundation for designing instruction and media selection, five major categories of learning with distinct internal and external conditions required for each type of learning, and eight hierarchical levels of intellectual skills(Ragan & Smith, 2013). Gagné's well-known "Nine Events of Instruction(Kruse, 2009)" are representations of his cognitive constructions and learning categories, which include verbal knowledge, intellectual skills, cognitive strategies, physical skills, and attitudes. These activities are said to offer the prerequisites for learning as well as the proper media choices.

2.1.2 Constructivist Theory

A general theoretical framework for instruction based on the study of cognition is known as constructivist theory(Bednar et al., 1992). The fundamental tenet of constructivism states that students choose information from prior and current knowledge to create new constructions and judgments. To complement the learners' existing knowledge, foster discovery, and allow the learners to build on prior accomplishments, the educator makes new material available through discussion.

2.1.3 Constructionism Theory

Constructivist learning theory is the foundation of constructionism theory. In his chapter "Situating Constructionism" in the book "Constructionism," which was co-edited by Seymour Papert and Idit Harel, Seymour Papert, a student of Piaget's, asserts that learning happens "most felicitously" when creating a public artifact, "whether a sand castle on the beach or a theory of the universe."(Harel & Papert, 1991) When he writes about the difficulties of communicating a complex idea when the reader is going to create his or her own meaning, Seymour does veer toward the constructivist learning theory. However, in general, his point is more about methodology. He thinks that if students are creating something that others will see, judge, and possibly utilize, they will be more profoundly engaged in their study. The complicated problems that the students will encounter as a result of that construction will encourage them to try to find solutions and learn new things. Confusion between constructivism and constructionism is caused by (a) words with similar appearances and (b) the word "construct" having several meanings(Chiari & Nuzzo, 1996). Piaget discussed the formation of mental constructions; philosophical constructivists discuss the uniqueness of these creations (noun construction); and Papert merely asserts that building is an effective method for creating mental constructions. From the physical (constructionism) to the mental (constructivism), from theory to philosophy to method, from science to approach to practice, levels are changing in this situation. "Giving children good things to do so that they can learn by doing much better than they could before" is what constructionism refers to(Papert, 1988). Children can now learn mathematics as a part of something genuine thanks to modern technology, which is incredibly rich in new activities.

2.1.4 Mental Processes

Many experts concentrate on mental processes, including how thoughts arise and how behaviorism emerges from mental processes. This system evaluates the learning outcomes or behaviors. Hence, instructional design can be applied to cognitive, behavioral, and attitudinal learning, encompassing cognitive strategies(Pressley & Hilden, 2006), fostering comprehension(Palinscar & Brown, 1984), applications within cognitivism(Cooper, 1993), establishing situated cognition and adhering to elements of situated cognition(Kirshner & Whitson, 1997), building upon cognitive or mental phenomena, cognitive activity(Erkinovna, 2022), cognitive organizers(Boyle, 1997), cognitive structure(Frijda, 1987), and the functioning of memory processes. This instructional design framework's cognitive, behavioral, and attitudinal learning processes are all relevant. As a result, it offers a set of guidelines to adhere to for each instructional event in order to improve learning, for instance as a micro theory. Nine instruction-related events are identified by the learning processes that are related to the cognitive strategies learning theory. The first event in the theoretical framework for instructional design is "attention," which is similar to the first event in the cognitive

processes learning theory. By encouraging recollection of necessary learning connections and memory activation, the subsequent event, "informing of the objectives," further initiates a process of getting the trainees' "attention" focused. We'll go over the nine events of instruction in more depth. In doing so, references to pertinent aspects of the social learning theory will be made for further details. Gagné created a nine-step method known as the events of construction. These describe the relationship between an instructional experience and a learner's internal thinking process. As stated in Gagné's nine events of teaching(Kruse, 2009b), interactive content in an e-learning course can hold the learners' attention.

Table 2.1 Gagné's nine events of instruction(Kruse, 2009b)

Instructional event	**Internal mental process**
1. Gain attention	Stimuli activates receptors
2. Inform learners of objectives	Creates level of expectation for learning
3. Stimulate recall of prior learning	Retrieval and activation of short-term memory
4. Present the content	Selective perception of content
5. Provide "learning guidance"	Semantic encoding long term memory
6. Elicit performance (practice)	Responds to questions to enhance encoding and verification
7. Provide feedback	Reinforcement and assessment of correct performance
8. Assess performance	Retrieval and reinforcement of content as final evaluation
9. Enhance retention and transfer to the job	Retrieval and generalization of learned skill to new situation

2.1.5 Learning by Doing Approach

Learning by doing is the most well-liked and successful method of learning that psychology and educational institutions have ever used. Practical exercises are used to develop skills for vocations or occupations in various learning methods. There is mention of group members' technological or technical experience. The constructivist learning theory, the ways of doing and thinking, and humanism(Davies, 2008) are also highlighted. Learning by doing, which concentrates on knowledge production based on the learner's prior experience, is generally agreed to be a suitable fit for e-learning(Noesgaard & O Rngreen, 2015). Constructivism learning theory is described as the active construction of new knowledge based on a learner's prior experience and is

deeply ingrained in the learning processes theories advanced by Dewey(Herman & Pinard, 2015), Piaget, and Vygotsky. According to Woolfolk, the most important concept is that students actively create their own knowledge because their minds interpret information from the outside world to decide what they will learn(Abd Rahman et al., 2008). Learning is an active mental process rather than a passive assimilation of information, according to Koohang, Riley, and Smith(Moak, 2014). Honebeins put up a list of objectives to help constructivism be designed in educational contexts. The seven objectives(Honebein, 1996) are to: "provide experience with the knowledge construction process, provide experience in and appreciation for multiple perspectives, embed learning in realistic and relevant contexts, encourage ownership and voice in the learning process, embed learning in social experience, embed learning in multiple forms of representation, and encourage self-awareness in the knowledge construction process."

2.1.6 Social Context

Focus is placed on situating constructionism(Papert & Harel, 1991), knowledge-building(Scardamalia & Bereiter, 2010), society and situation(Bennett & Campone, 2017), situated learning, social negotiation(Dutton, 2022), social construction, constructionism and constructivism (Martin This emphasis includes how thoughts grow in the creation of a theory of learning and a framework for educational advancement. According to this argument, a social context is necessary for a learner to construct and refine his ideas(Maloney et al., 2004). The person needs to come up with a concept. The individual cannot acquire it through a teacher, peer, or book. The person develops their own concept. This core idea that knowledge is produced more successfully when a person is involved in the development of "personally meaningful products" is then supplemented by constructionism. In constructionism, the outcome is just as significant as learning new information. The curriculum must be thoughtfully created when used in the context of vocational internet-based training in order to include the student and arouse his passion for the result. Online training should inspire students to create useful online tools. It is asserted that the learner won't participate otherwise. The social and instructional design paradigm 'link[s] competence and competency to performance' in order to prepare students for the workplace(Ertmer & Newby, 2013). Competence and competency are both derived from industry standards, which are crucial to the work that students must complete. Vocational education courses give students the opportunity for hands-on learning and experience with it(Sangsawang, 2020). Practical or hands-on components are translated into conceptual understanding when electronic learning (e-learning) is incorporated into vocational education. The components of their subject are not visible to or touchable by students. When only conventional materials are available, misconceptions regarding the topics presented in class may arise when teachers incorporate abstract concepts into vocationally focused learning(Sangsawang, 2018).

A paradigm for the creation and use of interactive technology has emerged from notions about the meaningfulness of learning processes. Its goal is to offer plausible contexts, such as those proposed by the constructivist, constructionist, and Gagné theories. To develop online learning and instructional design and to promote active knowledge construction and the solution of complex and realistic problems by learners, all three theories place a similar emphasis on mental processes, the learning-by-doing approach, and social context(Ertmer & Newby, 2013b). All three theories—Gagné's

theory, constructivist theory, and constructionism theory—concentrate on social structures, learning by doing, and mental processes. They pertain to new concepts that originate prior to the development of new learning media and include notions previously displayed in the cognitive structure. These theories provide a framework for integrating technology into the teaching and learning process, allowing educators to create meaningful and interactive learning experiences (Joseph & Khan, 2020).

For the purpose of creating a blended collaborative knowledge construction learning model for vocational education, the researcher would like to synthesize the six theories described above utilizing the Delphi technique. In other words, the goal is to develop a knowledge construction–based blended collaborative learning approach for vocational education. With the aid of this framework, students will be better able to understand concepts than they would have been able to with more traditional teaching methods, and they will be more successful and efficient in achieving their learning goals. The constructivist, constructionist, and Gagné's theories of psychology were used by the researchers to establish a new model that served as the framework. Using the Delphi technique, all three theories concentrate on learning processes (mental processes, learning-by-doing approach, and social environment).

2.2 Blended Learning in Vocational Education

Learning Outcomes and Effects: Numerous studies have focused on the impact of blended learning on learning outcomes and effects. Some research has found that blended learning can enhance students' academic performance, knowledge acquisition, and skill application(Ashraf et al., 2022; Gong et al., 2021; Vo et al., 2017). Other studies emphasize that students are more actively engaged in learning activities within blended learning, promoting deeper-level learning(Danker, 2015; Sun et al., 2017; Zhang et al., 2019).

Learning Experience and Satisfaction: Research has also explored students' learning experiences and satisfaction in blended learning. The majority of studies have found that students hold a positive attitude toward blended learning, perceiving it as offering a more flexible, diversified, and personalized learning experience that enhances their motivation and interest in learning(Halverson & Graham, 2019; Setyaningrum, 2018; Zhang et al., 2020).

Teaching Methods and Strategies: Research has addressed the teaching methods and strategies employed in blended learning. Researchers have explored how different teaching activities, such as discussions, case analyses, and practical exercises, can be integrated into both face-to-face and online instruction to enhance learning outcomes(Suartama et al., 2019; Mortera-Guti E Rrez, 2006).

Technical Support and Digital Literacy: Some studies have focused on the technological support needs of students and educators, as well as methods for cultivating students' digital literacy and technological skills within blended learning(A. Nortvig, A. K. Petersen, & S. O. R. H. Balle, 2018). Suggestions from researchers include providing technical training and designing user-friendly online platforms.

Teacher Roles and Training: In blended learning, there has been a shift in the role of educators toward that of facilitators and supporters(Comas-Quinn, 2011). Researchers have studied the transformation of teacher roles in blended learning and how to provide training and support for educators.

Challenges and Limitations: Research also highlights challenges and limitations faced in implementing blended learning in vocational education. These challenges encompass issues such as limited technological infrastructure, fostering students' self-directed learning abilities, curriculum design, and resource development(Guri-Rosenblit & Gros, 2011).

In conclusion, previous research indicates that blended learning in vocational education has a positive impact on improving learning outcomes and enhancing the learning experience and satisfaction. However, the successful implementation of blended learning requires addressing technological and instructional challenges to ensure optimal educational outcomes.

2.3 Collaborative Learning Strategies

Based on previous research, viewpoints on the study of collaborative learning strategies can be summarized into several main categories:

Learning Outcomes and Effects: Numerous studies have focused on the impact of collaborative learning on learning outcomes and effects. Some research has found that collaborative learning can enhance students' academic performance, knowledge acquisition, and problem-solving abilities. Collaborative learning facilitates deeper-level learning and encourages students to approach problems from multiple perspectives(Sun et al., 2017b).

Learning Motivation and Engagement: Research indicates that collaborative learning can boost students' learning motivation and engagement(Jacobs & Renandya, 2019). The collaborative learning environment sparks students' interest, making them more actively participate in course activities and enhancing the enjoyment and involvement in learning.

Social Interaction and Communication Skills: Collaborative learning contributes to the development of students' social interaction and communication skills(Silva et al., 2021). Through cooperating with peers, discussions, and sharing viewpoints, students enhance their teamwork, communication, and conflict-resolution abilities.

Knowledge Sharing and Construction: Collaborative learning encourages students to share and construct knowledge(Panitz, 1999). Studies reveal that through collaborative discussions and interactions, students can better comprehend and apply learned concepts, thereby deepening their understanding.

Cross-Cultural Collaboration: Some research has focused on collaborative learning in different cultural contexts(Yang et al., 2014). Researchers have explored the effects of cross-cultural collaboration and how to facilitate effective collaboration and communication in diverse multicultural environments.

Technical Support and Tools: Collaborative learning often utilizes technological tools such as online platforms, social media, and collaboration software(Ansari & Khan, 2020). Research investigates various technical support and tools, as well as how to maximize the advantages of these tools.

Teacher Roles and Guidance: Research also addresses the roles of teachers and their guidance in collaborative learning. Teachers need to provide appropriate guidance and support to ensure the smooth progress of collaborative learning(Van Leeuwen & Janssen, 2019).

Overall, previous research indicates that collaborative learning strategies have a positive impact on improving learning outcomes, enhancing learning motivation, fostering social interaction skills, and promoting knowledge sharing and construction. However, effective implementation of collaborative learning also requires consideration of factors like cultural differences, technical support, and teacher roles.

2.4 Knowledge Construction in Blended Learning

Based on previous research, viewpoints on the study of knowledge construction in blended learning can be categorized and summarized into the following main aspects:

Concepts and Theories of Knowledge Construction: Many studies have explored the concepts and theoretical frameworks of knowledge construction in blended learning(Shea & Bidjerano, 2010; Milad, 2019). Researchers have explained how knowledge is collectively constructed and understood in blended learning environments from perspectives such as cognitive constructivism and social constructivism.

Collaborative Knowledge Construction: Numerous studies have focused on how students collaboratively construct knowledge through interactive engagement(Qureshi et al., 2023). Researchers have investigated how collaborative strategies like online discussions, collaborative projects, and team activities facilitate the co-construction and sharing of knowledge.

Teacher Roles and Guidance: Research has also emphasized the roles of teachers in blended learning, particularly their guidance in the process of knowledge construction(Johler, 2022). Scholars have examined how teachers stimulate critical thinking, lead discussions, and provide timely feedback to foster knowledge construction.

Technological Support and Tools: Technological tools are crucial for knowledge construction in blended learning. Researchers have explored how online collaboration platforms, multimedia resources, and virtual experiments enhance students' knowledge construction and interaction(Al-Samarraie & Saeed, 2018).

Interdisciplinary and Real-World Application: Some studies have focused on interdisciplinary knowledge construction and the application of knowledge in real-world contexts(Widjaja et al., 2019). Scholars have investigated how blended learning promotes the integration of diverse field knowledge and the application of theoretical concepts to practical problem-solving.

Learning Motivation and Engagement: Knowledge construction also influences students' learning motivation and engagement(Afflerbach & Harrison, 2017). Researchers have studied how students maintain a positive learning attitude and active participation during the process of collaborative knowledge construction.

Assessment and Evaluation: Evaluation of knowledge construction is a focal point of research(Kvale, 1996). Scholars have explored effective methods to assess students' knowledge construction processes and outcomes in blended learning.

In conclusion, previous research indicates that knowledge construction in blended learning is a complex and multidimensional process involving students, teachers, technological support, and instructional strategies. Effectively promoting and guiding students' knowledge construction is a significant challenge and objective in the design of blended learning.

2.5 Delphi Technique

This review covers three areas that focus on the Delphi technique, and its application when used in an instructional design framework, as follows:

2.5.1 Definition of The Delphi Technique

Written questionnaires are used in this method to counteract personal factors and the influence of strong personalities. The approach is based on the findings of a questionnaire system in which a panel of experts receives multiple rounds of surveys. After each round, a collection of their private comments is made and delivered to the panel. In the following rounds, the panelists are permitted to modify their responses. There are several "correct" responses offered in response to the various rounds of questions, and each panel member is given the consensus for that round (Yousuf, 2019; Hanafin, 2004).

The Delphi method is "characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem."(Yousuf, 2007)

Compared to survey research, this method offers researchers more and more varied options. This strategy needs effective communication, a team of experts, and critical feedback.

The Delphi technique was developed in 1953 to obtain the opinions of military leaders regarding the need for ordnance during a time of war. Since then, it has been accepted and used as a strategy to get ready for a variety of challenging circumstances that can arise in the future. It consists of numerous rounds of questions distributed to a chosen group of well-known individuals who are authorities in their fields. Up until a final consensus is reached, each round's responses are developed and used as the basis for questions in the subsequent round(Kezar & Maxey, 2016).

2.5.2 The Delphi Technique and Decision Analysis

The consensus judgment reached by experts must be examined using the Delphi method. The information is gathered and analyzed according to formal guidelines. The Delphi process has been replaced by the consensus approach.

Table 2.2 The strengths and limitations of the Delphi technique

Strengths of the Delphi technique (Fink et al., 1984)	**Limitations of the Delphi technique** (Yousuf, 2019b)
- A panel of experts is selected to provide information and reach a consensus.	- Quality of response depends on the panel.
-This formal consensus method has become part of the system for solving problems.	- Researchers must choose participants selectively.
-The consensus method assists in collecting and evaluating the information provided by the experts.	- Interactions between participants and researchers are not face-to-face.

Some experts said that: “The characteristic Delphi technique is a method for structuring a group communication process so that the process is effective in allowing a

group of individuals, as a whole, to deal with a complex problem" (Donohoe & Needham, 2009)

In addition, Gordon claimed that answering the right questions is a controlled discussion and a potent method(Koriat & Goldsmith, 1994). According to Pollard and Pollard(Pollard & Pollard, 2004), the questionnaire technique enables a team of specialists to carefully examine and take into account every facet of a problem that has been presented to them. The first round of questionnaires will draw knowledge from the experts that they have gathered over many years by using a narrative in open-ended questions.

The consensus and analysis procedures are a part of the Delphi Techniques, and the Delphi and nominal group consensus methods contain formal rules for gathering and analyzing expert opinions.

2.5.3 The Application of the Delphi Technique Delphi

- The Delphi technique, which has a very broad range of applications, is seen from a wide variety of angles by experts(You, 1996).
- Examples include the following: -Collecting inaccurately known or accessible current and historical facts -Analyzing historical events
- -Budgetary considerations and feasibility studies
- - The viability of urban and regional planning
- -Creating educational curricula
- -Pros and cons of potential policy choices
- -Determining true and false human motives -Identifying and enhancing causal links in complicated economic or social phenomena
- recognizing significant social and personal objectives.

2.5.4 The Modified Delphi Technique in Instructional Design Frameworks

The Delphi method was created to collect feedback from participants without requiring face-to-face interaction. The method is frequently used to bring specialists with contrasting opinions and viewpoints together. Using an iterative process of problem description and debate, feedback, and changes, the Delphi technique facilitates collaborative problem-solving. Using mail or email, the modified Delphi technique described here solicits data, solicits feedback, and reports findings.

The planning committee or sponsor must finish the preliminary work. The organizing committee or sponsor must specify the issue or problem to be discussed, and they must select a communications manager to distribute messages, gather feedback, and provide summaries. The initial questionnaire that will be distributed to participants should be written or reviewed by the planning committee.

2.5.4.1 Round One - First Questionnaire: The first round of the survey asks participants to identify as many possible responses (ideas, solutions, approaches, etc.) in response to a defined problem or issue. If the survey is being sent by mail, the response form will only state the question and offer blank spaces for answers. The email message is made to allow input after selecting the "reply" email option if using email. What steps could our committee take to increase retail sales in the downtown area, as an example? "What should be our subject for this year's festival? ", or "List as many as you can using just a few words or a phrase. Use only a few words or a phrase to

enumerate as many concepts as you can. Anonymous responses are provided by participants(Turoff & Linstone, 2002; Linstone & Turoff, 2011).

Round One-Compiling responses: The second questionnaire is created by the communications manager after compiling all the replies and including room for participants to reply to each topic.

2.5.4.2 Round Two-Second Questionnaire: Participants are asked to rate each thought in the second questionnaire, which incorporates all the responses. Participants are urged to elaborate on or contribute to ideas, remark on their viability, come up with new ideas and develop more implementation plans. Anonymous responses are given by participants(Turoff & Linstone, 2002).

Round Two-Compilation of Responses: The list of suggestions is still being developed by the communications manager and currently contains comments, additions, clarifications, and tactics. With the extra data from round two, the communications manager created the third questionnaire.

2.5.4.3 Round Three-Third Questionnaire: The process of gathering information, disseminating it to participants, and getting feedback is repeated by the communications manager. According to other criteria, such as "my willingness to work on this project," the third questionnaire can ask respondents to rate ideas in terms of importance or timeliness(Turoff & Linstone, 2002).

Round Three-Compilation of Responses: Unless the planning committee determines that participants require more rounds of input and feedback, this is the last opportunity to compile responses. Participants have recognized and prioritized the workable ideas in this round's resolution and report. The group receives a response from the communications manager who presents ideas or plans together with implementation details in priority order. Participants have recognized and prioritized the workable ideas in this round's resolution and report. The group's ideas or plans are presented to them by the communications manager along with implementation information prioritized by the group.

2.6 Literature Review of Relevance of Research

Systematically reviewing empirical studies that examined the usefulness of the Delphi technique, Rowe and Wright offered a critique of this research(Rowe & Wright, 1999). There is some evidence that Delphi groups perform better than statistical groups (by 12 studies to 2 with 2 "ties") and traditional interactive groups (by 5 studies to 1 with 2 "ties"), however, there is inconsistent support for this claim. Generalizations concerning "Delphi" per se are challenging because there are significant discrepancies between the conventional laboratory version of the technique and the original notion of Delphi. These disparities result from the inability to control crucial group, task, and procedure features (such as the amount of experience of the panelists and the type of feedback given). In fact, there are theoretical and empirical arguments in favor of the hypothesis that a Delphi done under "ideal" conditions might outperform the conventional laboratory interpretations. It is concluded that an alternative research approach, concentrating on an analysis of the process of judgment change inside nominal groups, is necessary to address doubts about the effectiveness of the Delphi method.

In their landmark meta-analysis of thrombolytic therapy, Verhagen, Vet, Con, Vermeer, et al.examined the impact of methodological quality on the analysis's result(Verhagen et al., 2002). The majority of systematic reviews heavily rely on the evaluation of the individual studies' methodological quality. This study sought to find a collection of generic core questions for randomized clinical trials (RCTs) quality assessment that experts could agree on. The invited participants were authorities on evaluating the quality of RCTs. All of the items from the first criteria lists were included in the item pool. The number of items was then lowered using the Delphi consensus method. A questionnaire, an analysis, and a feedback report were all included in each Delphi session. Decisions made by the staff team based on the analysis and their reasoning were mentioned in the feedback report. 33 worldwide experts in all consented to take part, and 21 of them completed all questions. In three Delphi rounds, the starting item pool of 206 things was decreased to 9 items. All participants were pleased with the final criteria list (also known as the Delphi list). It serves as a starting point for the development of a minimal reference standard for RCTs across a wide range of research areas. This list should be used in addition to current criterion lists rather than as a replacement for them.

Sangsawang, Jitgarun, and Kiattikomo compared Gagné's theory, constructivism, and constructionism(Sangsawang et al., 2006), three different psychological theories. The Delphi technique was used in this study's comparison of the chosen theories.17 specialists were the sample selected for this investigation. Semi-structured interview forms and questionnaires with rating scales served as the data-gathering tools. Using interquartile range, mode, and medium, data were statistically evaluated. The following aspects of the chosen psychology theories were compared: their models, their components, and their teaching and learning processes.

Sangsawang, Jitgarun, and Kiattikomol used the Delphi method to conduct research on a learning strategy appropriate for learners' self-discovery(Sangsawang et al., 2006). 17 specialists were the sample selected for this investigation. A 5-star rating scale questionnaire served as the data-gathering tool. In order to statistically examine the data, the modes, medians, and interquartile ranges were used. These were the findings of this study: Seven steps must be followed by learners in order to reach self-discovery. To improve learning attention, it is necessary to examine the previous experiences of the learners and to inform them of expected actions. Second, both teachers and students need to analyze problems. Third, the advice is provided in accordance with the interests, aptitudes, and skills of the students. Fourth, students must change their views and respond to the questions. Fifth, students will remember, explain, criticize, examine, summarize, and resolve the issues on their own. Sixth, by exchanging ideas with others, students will reflect on their own methods of thinking. The seventh and final step in the process of self-discovery for learners will be feedback and evaluation. In actuality, with the assistance or facilitation of the instructors, as in the first, second, third, and seventh steps, the learners' self-discovery of learning would succeed. The level of facilitation should, however, be determined by the skills, interests, and aptitudes of the learners.

In Sangsawang, Jitgarun, and Kiattikomol's study, students' self-evaluations of online learning were taken into consideration. This study looked at how well students thought of their own online learning. 100 students from Rajamangala University made

up the sampling group for this study. A questionnaire served as the data-gathering tool. Utilizing frequency, proportion, and content analysis, data were examined. The study's findings were as follows: 1) While most students are interested in learning new skills, they prefer face-to-face connection and require professors to regularly remind them of deadlines and assignments, 2) Since most students can attend campus at any time and have less time to devote to an online course than to a class there, online learning is a personal interest that could be put off. 3) In addition to the other points mentioned, most students need to be reminded to complete assignments on time, they occasionally benefit from class discussions, they attempt to follow instructions independently before seeking assistance when necessary, and occasionally they want assistance to comprehend the text.

Using the Delphi method, Sangsawang, Jitgarun, and Kiattikomol presented a synthesis of constructivism, constructionism, and Gagné's theory-based learning theories' contributions to online learning and instructional design. 17 specialists were the sample selected for this investigation. Semi-structured interview forms and questionnaires with rating scales served as the data-gathering tools. Using interquartile range, mode, and medium, data were statistically evaluated. Gagné's theory, constructivism, and constructionism were found to place a strong emphasis on three aspects of meaningfulness in instructional design and online learning. These included 1) fundamental ideas like building a body of knowledge through self-enlightenment and laying the groundwork for comprehension; 2) organizing techniques like simulation; and informing students of the faculty's expected results; and 3) instructional methods like drills and practices, tests, games, tutorials, and inquiry method.

The instructional design of electronic media based on the theories of Gagné, constructivism, and constructionism (GCC Model) was examined by Sangsawang, Jitgarun, and Kiattikomol (2008:2-11). This study aimed to combine the instructional design model that was based on the three theories. 17 Thai professionals who discussed the use of such methods in instructional design provided the data. A semi-structured interview was also conducted. Data were examined using content analysis, and the validity of the content was confirmed (.97). The outcomes showed that these three steps should be taken in managing the GCC model. First, operant conditioning consisted of five steps: (1) focusing attention; (2) activating prior knowledge; (3) letting learners know what results were anticipated of them; (4) modifying circumstances to encourage a thought process; and (5) supplying learning guidelines. Second, there were three steps to learning control techniques: (1) looking for solutions and (2) adapting or modifying their thought processes. (2) assessing, applying, and reflecting on their thoughts through memorization. The learners' discovery of their own learning was the third topic covered by learning control strategies. Task-based learning, learning contracts, lectures, panel discussions, self-directed learning, mentoring, small-group work, projects, collaborative learning, case studies, and forums were some of the strategies used. It was explained and discussed how to create a model, as well as how to use learning control techniques and operant conditioning, which are the foundations of the new model. The next stage of the project would involve developing an electronic media instructional design model based on the GCC model. Writing about the promise of technology and encouraging learning skills and its realization, Barak and Shachar. The graduation projects that 12th-grade students at Israeli high schools prepare in areas like electronics, control systems,

and robotics are a crucial part of the technology education program. Project work is a fantastic way for students to develop general abilities like problem-solving, creativity, and teamwork. On the other hand, it has lately been considered that after around 10 years of encouraging schools to involve students in projects, it is time to improve the pedagogical side of project work in order to promote meaningful learning and the development of higher-order intellectual skills. A program to reform students' project work in school was launched in 2009 by a team from Ben-Gurion University of the Negev and the Ministry of Education's Chief Inspector for teaching electricity and electronics, with a focus on encouraging self-regulated learning (SRL) among the students. The program involves directing teachers and students in many pilot schools as part of the reform process, producing new project-preparation standards for students and instructors, and providing in-service training courses for teachers. In their paper, they examine the ways in which the self-regulated learning theory can be used in technology education as well as the preliminary results from the aforementioned investigation.

There is a need for practical guidelines and recommendations to facilitate the development and delivery of pedagogically effective eLearning environments where an instructional design model for online learning in higher education, such as online learning (or eLearning), is integrated into an ever-increasing number of university courses, according to Kanuka(Kanuka, 2006). The effectiveness of instructional design concepts and learning methodologies for higher education students studying in these contexts was recently studied by Siragusa in research(Siragusa & Dixon, 2005). In Western Australian institutions, surveys of students and lecturers revealed a variety of aspects of students' eLearning experiences that they had perceived as successful and those that needed improvement. In order to design, develop, evaluate, and improve their eLearning environments in higher education, lecturers and instructional designers may use the model presented in this paper, which was created using the survey results of the study. The approach is supported by suggestions that take into account the various educational requirements of students and the various ways that courses are delivered. To highlight the various pedagogical needs and instructional requirements, a pedagogical dimension is offered for each recommendation. In a similar way to Rowe and Wright, the dimensions are used. The pedagogical dimensions highlight the choices that must be made for the implementation of pedagogically effective eLearning environments during the instructional analysis, design, delivery, and evaluation phases.

2.7 Literature Review Summarization

Synthesizing the literature, findings from studies on blended learning, collaborative learning strategies, and knowledge construction within blended learning in vocational education underscore the significance of the blended collaborative knowledge construction learning model. Research commonly asserts that blended learning offers vocational education flexibility, personalized learning, and the fusion of theory and practice, resulting in substantial improvements in students' academic achievements, knowledge acquisition, and problem-solving abilities. Collaborative learning strategies foster positive learning motivation and engagement, cultivating social interaction, communication skills, and collaborative knowledge construction. In the context of blended learning, the knowledge construction process encourages students to approach problems from various angles, enabling interdisciplinary integration and real-world

application. However, current research also highlights certain limitations, such as inadequate technological support, challenges posed by cultural differences, and the need for teacher role transformation. These research gaps prompt further exploration of how to effectively implement the blended collaborative knowledge construction learning model in vocational education. Future research can delve into addressing these issues, optimizing model design, and formulating practical teaching strategies to further advance the effective implementation and development of the blended collaborative knowledge construction learning model in vocational education

CHAPTER 3
RESEARCH METHODOLOGY

The research used quantitative and qualitative methods to answer the research questions and guided the researcher to collect and analyze the data. This chapter was conducted according to the following structure:

3.1 Research Design
3.2 Instrumentation
3.3 Delphi Technique
3.4 Data Collection
3.5 Statistical Analysis

3.1 Research Design

The research design was conducted according to the following structure in the objective of the research; it has been moving with steps as flowing:

3.1.1 Design a blended collaborative knowledge construction learning model by integrating the relevant theories of the learning process of blended collaborative knowledge construction.

3.1.2 Connected with 17 qualified experts to request their agreement to participate in the study using the questionnaires interview.

3.1.3 The information gathered through questionnaires, observations, and interviews about how teaching and learning are designed. The research-prepared questionnaire, frequency and percentage data analysis, and Likert's five-point rating scale were all used. Utilizing the mean (M), standard deviation (SD), and correlation, the five-scale portion was examined. An average score of 1.00-1.49 indicates strong disagreement, and an average score of 4.50-5.00 indicates agreement, according to the respondents' levels of agreement.

3.1.4 Students learned with the blended Collaborative Knowledge Construction Learning Model, and comparing the achievement test, the researcher conducts a questionnaire form to the students to understand how they react to the research tools. In the second semester of the 2022-2023 academic year, the number of students in the experimental group participating in the blended collaborative knowledge construction learning mode is 30, and the number of students in the control group with traditional learning methods is 30.

3.2 Instrumentation

3.2.1 Semi-structured interviews: First-round interviews were semi-structured; brainstorming was tied to the framework from Gagné's theory, constructivism, and constructionism; all three theories place emphasis on mental processes, learning by doing, and social context. Principles, teaching-learning activities/strategies, teaching-learning environments, and teaching-learning models were the four sections of the interviews. The purpose of the semi-structured interviews was to question experts to get their viewpoints on each concept.

Four components make up the interview process for developing the Question I conceptual framework for Gagné's theory, constructivism, and constructionism. These

were the following: guiding principles, teaching-learning activities/strategies, teaching-learning environments, and teaching-learning models.

3.2.1.1 From Gagné's theory on mental pocesses (Clark, 2018), there were questions about 'principles':

a. "What do you think about the principles of Gagné's theory that cover the contents for instruction?" For instance, instructors organize knowledge through experiences, the creation of internal and external conditions, the development of instructional events in learning and memory to aid students in learning more effectively, the encouragement of learning events, the regulation of the teaching process at specific stages as a means of systematic and adaptable instruction, and the creation of promotion in learning events;

b. "What do you consider to be 'teaching/learning environments' in Gagné's theory?" For example instructors, learners, stimulus, and response performance;

c. "What are the stages of 'teaching-learning activities/strategies' in Gagné's theory?" Examples include drawing attention to motivate students, inspiring students to want to study, and choosing stimulating materials like books, images, classes, and movies. Participation in instruction can be viewed as asking questions and educating students about the objectives since they are aware of what has to be done and how to do it, the purpose of the lesson, and how to prepare the topic in advance. Students get a full understanding of the value of what they are learning when they are informed of the goals of each learning unit;

d. "What are 'teaching-learning models' in Gagné's theory?" For instance, the discovery approach, offering learning direction, presenting the stimulus, eliciting a response, giving feedback, enhancing retention and transfer, programmed instruction, tutorial instruction, simulation instruction, games-based instruction, drills, and practice instruction, and tests instruction or a series of test items can all be used to help students learn more effectively.

3.2.1.2 From constructivism as a focus on learning by doing approach (Booyse, 2010), there were questions about 'principles':

a. "How do you think the theory of "constructivism" covers contents in instruction?" For instance, it assesses students' prior knowledge before imparting new information, reviews students' prior knowledge, and connects it to new information, students analyze from prior knowledge and new information, the knowledge base is the earlier stage from which something new is learned, shows and contrasts what is right and wrong in the new contents, provides an analysis and summary of debates, uses a variety of materials and questions as examples during teaching, and shares ideas with students;

b. Questions about 'teaching-learning environments' included: "What do you think about the elements of constructivism theory?"For instance, what it means for students, teachers, the setting, and ensuring that students comprehend before learning something new;

c."What are the stages of 'teaching-learning activities/strategies' in constructivism?" For instance, the activation of pre-existing knowledge, learners' self-concepts through a psychological self-assessment process, learners' comprehension of a given problem, observation by learners, interpretation of connections, learners'

revisiting of prior knowledge before delving into new material, formulating insightful questions, learners' quest for solutions, honing critical thinking abilities, employing a cause-and-effect approach to self-inquiry, learners' autonomy in selecting problem-solving methods, collaborative exchange of ideas among learners, cooperative study efforts, confirmation of discoveries, cultivation of individualized knowledge, tackling and resolving challenges independently, integrating previous knowledge into the overall knowledge structure, fostering cognitive skills advancement, nurturing intellectual thought processes, active pursuit of solutions, learners' comprehension validation and conclusions verification through discourse with peers, assessing students' grasp of a subject, transference of knowledge, application of knowledge, skills, and methodologies in elucidating decision-making processes for problem-solving, bridging freshly acquired knowledge with existing insights, appraisal of responses, analyzing data or information gleaned from inquiry, articulating group conclusions and concepts, summarizing findings;

d. There were questions about the 'teaching-learning models' of the theory of constructivism theory. For instance, the learning process known as self-learning has four components: perception, team-based or collaborative learning, the learning cycle, and cooperative learning. An illustration of independent learning, problem-based learning, and problem-solving techniques is project-based learning.

3.2.1.3 From constructionism as focus on social context (Galbin & Others, 2014), there were questions about 'principles':

a."Which aspect of the theory of constructionism covers the contents of instruction?" For instance, learner-centered learning, scientific learning methods, learning by doing, recognition of learners' roles as independent learners and creating their own understanding, active learning models created so that learners have new knowledge, and encouraging learners to be experts and capable of developing a model of thinking on their own are all examples of learning that fosters intellectual creativity.

b.Questions about 'teaching-learning environments' were: "What do you think are the elements of the theory of constructionism?" For example, the learners, the method, the instructors, and the environment;

c.Questions about the stages of 'teaching-learning activities/strategies' in constructionism theory? For instance, encouraging learning, boosting retention and transfer, activating prior knowledge, exchanging ideas, and transfer thinking;

d. Questions about 'teaching-learning models' of the theory of constructionism theory. Examples include learning by receptive style, learning through creative thinking, learning through discovery, learning through "group process" (as an example of independent learning), learning through avoidance, learning through participation, learning independently, and learning independently and dependently.

3.2.2 Questionnaire I: Questionnaire I was used for the second round: the evaluation of the experts' ideas on Gagné's theory, constructivism, and constructionism concerning an instructional design model for self-regulated, blended Collaborative Knowledge Construction Learning Model at the vocational level. To create questionnaire I, it included employing content validity to synthesize the data from the semi-structured interviews. The study was divided into four sections: principles, teaching-learning activities/strategies, teaching-learning environments, and teaching-learning models based on Gagné's theory, constructivism, and constructionism. These

models emphasized social context, learning by doing, and mental processes. Questionnaire I evaluated 17 experts in Gagné's theory, constructivism, and constructionism with regard to a self-regulated, blended Collaborative Knowledge Construction Learning Model at the vocational level.

Validity and dependability of Questionnaire; Reliability, commonly referred to as the Questionnaire's Reliability, is a term used to describe the consistency of the findings from numerous tests conducted using the same methodology on the same participants. For social sciences, the Cronbach's alpha coefficient approach is typically employed to measure dependability. In general, the internal consistency of the data is more noticeable and its believability is higher the larger the coefficient value. The research employed a five-point Likert scale (Boone Jr & Boone, 2012), as illustrated below. It takes about 10 minutes to complete the questionnaire, which is in Chinese.

1 = strongly disagree
2 = disagree
3 = neutral
4 = moderately agree
5 = strongly agree
Five-point Likert Scales

3.2.3 Questionnaire II: After receiving the completed questionnaire I, the results were generated and sorted into similarities and differences using a diagram chart. As stated in Appendix D, Questionnaire II employed a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = somewhat agree, and 5 = strongly agree). For the third round, it was given to the professionals.

3.2.4 Questionnaire III: Following the return of Questionnaire II, the responses were sorted, categorized, and reduced into key themes and recommendations before being forwarded back to all experts for assessment and agreement for the fourth phase. Questionnaire III received responses from seventeen experts.

3.2.5 Questionnaire IV: After all responses to questionnaire III, which included all of Gagné's theory, constructivism, and constructionism principles, teaching-learning activity strategies, teaching-learning environments, and stages of instructional sequence, were received, the major themes in the responses as well as the advice of the experts were identified, categorized, and condensed into Questionnaire IV. 'Confirmation' or 'Disconfirmation' and 'Reject' were the basis for Questionnaire IV, which also provided a theoretical framework for integrated collaborative knowledge building in vocational education.

3.3 Delphi Technique

3.3.1 First Round: Gagné's theory, constructivism, and constructionism were the main topics of the brainstorming session, which also covered mental processes, learning by doing, and social environment. The framework for the semi-structured interviews was created using the findings from this study.17 experts were allowed two to two and a half weeks to respond to and complete the first round of questions after receiving the questionnaire, which was delivered to them. After receiving the responses, the information was categorized, synthesized, and used to create a new questionnaire (Questionnaire I).

3.3.2 Second Round: This phase, known as the appraisal of the experts' thoughts, involves grading the experts' comments using a Likert scale. With regard to a learning model design of blended collaborative knowledge construction in vocational education, Questionnaire I was used in round two evaluations to manage the opinions of the experts on Gagné's theory, constructivism, and constructionism and summarize them with respect to similarities and differences. The commonalities indicated that the majority of the 17 experts concurred, but the disparities indicated the opposite order to create questionnaire II (using a five-point Likert scale), the results of the synthesis were employed. This questionnaire was then forwarded to the experts for the third round.

3.3.3 Third Round: The principles, teaching-learning activities/strategies, teaching-learning environments, and teaching-learning models from Gagné's theory (mental processes), constructivism (learning by doing approach), and constructionism (social context) regarding a learning model design of blended collaborative knowledge construction in vocational education were all included in this re-evaluation stage. The commonalities indicated that the majority of the 17 experts concurred, but the disparities indicated the opposite the questionnaire III (using a five-point Likert scale) was forwarded to the experts for the fourth round after the results of the synthesis were used to build it.

3.3.4 Fourth Round: By this point, the workable ideas had been located, dealt with, and reported. The specialists acknowledged every group member's viewpoint along with any proposals or methods and implementation specifics. Following the completion of Questionnaire III, the replies were sorted, organized, and condensed into significant topics along with the advice of the experts, and Questionnaire IV was created. The theoretical framework for a blended collaborative knowledge creation learning model in vocational education is based on Questionnaire IV, which was built around the concepts of "Confirmation" or "Disconfirmation" and "Reject."

3.4 Data Collection

The data were collected using the Delphi technique. There were four rounds for the data collection as follows:

3.4.1 First Round: Brainstorming

Gagné's theory, constructivism, and constructionism, all of which place an emphasis on mental processes, the learning-by-doing method, and social context, were used in the first round to guide the experts' brainstorming through semi-structured questionnaires. Following was the first round of data-gathering process:

1）The researcher made contact with, called, or otherwise made contact with 17 qualified experts to solicit their consent to take part in the study utilizing the Delphi methodology.

2）The researcher provided formal letters on behalf of the Faculty of Technology Education at Rajamangla University of Technology Thanyaburi (RMUTT) once all 17 certified experts had concurred.

3）All qualified specialists were scheduled for consultations on the specified date and time.

4）All the specialists present at the appointment received the questionnaire.

5）The questionnaire was filled out by 17 experts through mail and returned to the researcher. These experts made no more remarks.

6）Answered queries and described the questionnaires' objectives.

7）To determine the consensus, the researcher divided the responses into comparable and dissimilar categories.

8）In order to create Questionnaire I, which addresses teaching and learning design based on the three psychology theories—Gagné′ theory, constructivism, and constructionism—that emphasize mental processes, the learning-by-doing method, and social context—data from the interviews were grouped and arranged based on the semi-structured questionnaire. The researcher used a five-point Likert scale when creating Questionnaire I. Frequency and percentage were employed in data analysis. The five-scale portion was examined using correlation, mean (M), and standard deviation (SD). According to the respondents' scores, there were two levels of agreement: strongly disagree (average score: 1.00–1.49) and absolutely agree (average score: 4.5–5.00).

3.4.2 Second Round: Evaluation of the Experts' Ideas

The second round evaluated the ideas using the Likert five-rating scale in Questionnaire II.

1）The researcher made contact with, called, or otherwise made contact with 17 qualified experts to solicit their consent to take part in the study utilizing the Delphi methodology.

2）After receiving approval from all 17 certified experts, the researcher invited the experts using official letters from the Faculty of Technology Education at Rajamangla University of Technology Thanyaburi (RMUTT).

3）All qualified specialists were scheduled for consultations on the days and times of their choosing.

4）At the appointment, Questionnaire II was distributed to each expert.

5）The questionnaire II was completed by 17 experts through the mail and sent back to the researcher. These experts made no more remarks.

6）The new information from the initial round of the open-ended questionnaire was then evaluated by the researcher to look for agreement. The semi-structured interview questionnaire's answers were used by the researcher to choose the items.

7）The outcome is a composite of the similarities and differences.

8）17 experts' data were collected through interviews and postal surveys.

9）Each question item's median, mode, and interquartile range were calculated.

10）Gagné's theory, constructivism, and constructionism are three psychology theories with a focus on mental processes, a learning-by-doing approach, and social context. Data on the similarities and contrasts between these three theories was synthesized. The researcher then developed a blended collaborative knowledge construction learning model.

3.4.3 Third Round: Re-Evaluation

In the third round, the 17 experts were required to respond to Questionnaire III.

1）Items were chosen based on Questionnaire II's findings. These comprised all guiding concepts, teaching-learning activity methodologies, teaching-learning

environments, and instructional stages that comprise social context, mental processes, and learning by doing.

2）The results were combined and compared for similarity or difference. Most of the 17 experts agreed based on the similarities, although the opposite was true based on the differences. The development of Questionnaire III was based on the synthesis's findings.

3）All qualified specialists were scheduled for consultations on the days and times of their choosing.

4）At the consultation, Questionnaire III was distributed to all experts.

5）17 experts opted to complete Questionnaire III by mail, which they then sent back to the researcher. These experts made no more remarks.

3.4.4 Fourth Round: Solution-Report

The experts reached a decision and produced a report in the fourth round after identifying the workable ideas. Additionally, the professionals appreciated every group member's viewpoint and provided suggestions, tactics, and implementation information.

3.4.5 Questionnaire IV data survey

The researcher conducted data research to establish a theoretical framework for a blended and collaborative learning environment by selecting 100 teachers who have created electronic media (such as e-books and e-learning, WBI (web-based instruction), and CAI computer-assisted instruction) in the field of vocational education such as electrical engineering, electrotechnology, civil engineering, and mechanical.

3.5 Statistical Analysis

3.5.1 With the assistance of the professors and experts, a preliminary study was completed. A five-point Likert-style scale was used for the survey. Questionnaires were used to collect the data, which were then processed to provide the findings. Frequency and percentage were used to assess the section with the chosen items. The five-scale portion was examined using correlation, mean (M), and standard deviation (SD). The researcher examined the data using mode, median, and interquartile range to analyze the consensus of 17 experts as follows:

(1)The value of the median should not be below 3.50.

(2)The absolute value of the difference between median and mode should not be above 1.00.

(3)The value of interquartile range (IQ_3 - IQ_1) should not be above 1.5.

(4)The IQR = Interquartile Range (IQR< 0.50 ≥ 1.00 = Congruent; IQR>1.00 = Incongruent).

Average and scale of experts' assessments of particular psychology theories. The mean, which is displayed in Table 3.1, was used to examine the differences in respondents' judgments on several psychology theories.

Table 3.1 Mean and level of experts' opinions of selected psychology theories

No.	*M*	Level of opinions
1.	1.00 – 1.49	Strongly disagree
2.	1.50 – 2.49	Disagree

3.	2.50 – 3.49	Neutral
4.	3.50 – 4.49	Moderately agree
5.	4.50 – 5.00	Strongly agree

Note: *M* = mean.

The following were the levels of the standard deviation, which is a gauge of how much a set of data deviates from the mean (Altman & Bland, 2005):

0.000-0.999 means less spread-apart data

More than 1.000 means more spread-apart data

The expert viewpoints on particular psychology theories, educational requirements, instructional strategies, and assessment methods were the qualitative data from the interviews and observations. When there were commonalities, some data were reduced. It was done using keyword analysis.

3.5.2 Examining and contrasting the student performance data from the experimental group's students who used the blended collaborative knowledge construction learning mode and the control group's students who used the traditional learning mode. Data analysis was carried out by the researcher in the manner described below:

3.5.2.1 To determine if blended collaborative knowledge construction learning methods are beneficial for students who meet the standard criterion of E1/E2 = 80/80, use the E1/E2 = 80/80 as a guide.

3.5.2.2 The first 80 represents the students' average score as determined by blended collaborative knowledge construction learning models used during the study time. After instruction, the test score has a value of at least 80%.

3.5.2.3 The second 80 represents the mean score for the percentage of correct answers provided by the students. The test score is worth at least 80 percent of the total possible points.

3.5.2.3 Utilizing a blended collaborative knowledge construction Leaning model to compare the learning outcomes of the experimental and control groups. Sample The student models linked samples using a t-test. Using the Likert five-level rating scale, a questionnaire analysis of students' opinions on blended collaborative knowledge construction learning was carried out. The results of the analysis are as follows:

5 points mean Strongly Agree.
4 points mean Agree.
3 points mean Undecided.
2 points mean Disagree.
1 point means Strongly Disagree.

3.5.2.4 By compiling all of the questionnaire responses and converting them into Mean (M) and Standard Derivation (SD) values, the score's interpretation was made possible. The final score will range from 1.00 to 5.00. The following translations of the score's meanings:

4.51 to 5.00 means indicate the highest level of opinion.
3.51 to 4.50 means indicate the opinions are high.
2.51 to 3.50 means indicate a moderate level of opinion.
1.51 - 2.50 means indicate the opinions are low.
1.50 - 1.00 means the comments are minimal.

The arithmetic mean formula Mean (*M*) in this study was:

$$\overline{X} = \frac{\sum X}{N}$$

$\overline{X}$ represent Arithmetic Mean.

$\sum X$ represent The sum of all score results.

N represent The number of students.

The formula of Standard Derivation (*SD.*) in the study was:

$$S.D. = \sqrt{\frac{\sum \left(x - \bar{x}\right)^2}{N}}$$

SD represents Standard Derivation.

x represent Student Score.

$\overline{X}$ represent Mean Score.

N represent The number of students.

The formula used for the percentage was:

$$P = \frac{f}{\mathrm{N}} \times 100$$

P represents Percentage.

f represents Frequency.

N represents the number of students.

The following statistics were used to assess the instrument quality: We used the IOC formula (Item Objectives Congruence) to determine whether the accomplishment test's content was valid.

$$\text{IOC} = \frac{\sum \mathrm{R}}{\mathrm{N}}$$

IOC represents the Index of correspondence between the test and the objective.

R represents Expert Rating.

$\sum$R represents the sum of individual expert scores.

N represents the number of experts.

Configuration expert scores were:

+1 means The test measures are precisely the learning objective.

0 means The Uncertainty the test measures is precisely what the learning objective.

-1 means The test does not measure precisely the learning objective.

The accomplishment test's difficulty index was determined using the following formula:

$$P = \frac{R_{H+}R_L}{N_H + N_L}$$

p represent Difficulty level.

R_H represent The number of people who chose the highest option rate.

R_L represent The number of people who chose the lowest option rate.

N_H represent The Total number of people in the high group.

N_L represent The Total number of people in the low group.

The following calculations were made to determine the accomplishment test's item discrimination:

$$r = \frac{R_H - R_L}{N_H or N_L}$$

r represent Discriminative score.

R_H represent The number of people who chose the highest option rate.

R_L represent The number of people who chose the lowest option rate.

N_H represent The Total number of people in the high group.

N_L represent The Total number of people in the low group.

The following formula was used to determine the accomplishment test's reliability:

$$r_{tt} = \frac{k}{k-1}\left[1-\frac{\sum pq}{S^2}\right]$$

r_{tt} represents The reliability score.

k represent The number of items in the quiz.

p represent The proportion of the right answer.

q represent The proportion of the wrong answer.

S^2 represent The variability of scores from the quiz.

The following formula was used to determine the accomplishment test's variability:

$$s\text{Two} = \frac{n\sum fx^2-\left(\sum fx^2\right)}{n(n-1)}$$

S^2 represent The variability of scores.

n represent the number of students.

x represent Achievement test scores.

f represent Frequency data.

The following statistics were used to support the claim: The dependent t-test was employed to analyze the variations in accomplishment scores and the following formula was applied:

$$t = \frac{\sum D}{\sqrt{\frac{n\sum D^2 - \left(\sum D\right)^2}{n-1}}}$$

$\sum D$ represent The sum of the variances scores of achievement tests.

$\sum D^2$ represent The sum of squares of the Difference of achievement test score.

$\left(\sum D\right)^2$ represent The sum of the variances score of the square test.

n represent The Total number of students.

D represents The Difference between the performance of each student in the experimental group and the control group.

Performance analysis of the E1/E2 based on standard 80/80 was calculated using the following formula:

$$E1 = \frac{X_1}{A_1} \times 100$$

E1 represents The Efficiency of the teaching process.

X_1 represents The mean score of the students in the class.

A_1 represent The full score of the exercise.

$$E2 = \frac{X_2}{A_2} \times 100$$

E2 represents The Efficiency of the teaching process.

X_2 represent The mean score of the students in the class.

A_2 represent The full score of the exercise.

CHAPTER 4
RESEARCH RESULT

This chapter makes a descriptive analysis and significant analysis of the blended collaborative knowledge construction learning model of vocational education. The categories summarize the results of the analysis of the interview and survey data. The tables summarize the results of the analysis of the Delphi technique.

4.1 Descriptive Data Statistics

4.2 Analysis Results

4.3 Effectiveness of Blended Collaborative Knowledge Construction learning model

4.1 Descriptive Data Statistics

4.1.1 First Round: Brainstorming

Brainstorming was done in the first round. Its goal was to combine learning process theories related to blended collaborative knowledge creation learning in vocational education, as stated in aim 1. based on Gagné's theory (mental process), constructivism (learning by doing method), and constructivism (social environment) of psychologyThe semi-structured interview form and interview plan (see appendix B)Principles, teaching-learning activities/strategies, teaching-learning environments, and teaching-learning models are the emphasis of the interview scheme and the semi-structured interview form (see appendix B). The framework based on the theories was then presented, and this included elements of the learning process as defined in Objective 1. It also contained the outcomes of the interviews or the first round of brainstorming. The development of the Questionnaire I followed, is seen in Tables 4.1 through 4.4 (see Appendix C).

4.1.2 Second Round: Evaluation of the Experts' Ideas

In order to synthesize learning process theories relevant to blended collaborative knowledge creation learning in vocational education, the ideas in Objective 1 were evaluated in a second round. Gagné's theory (mental process), constructivism (learning by doing approach), and constructionism (social context) were the three psychology theories that were evaluated, along with the fundamentals of teaching-learning activities/strategies, teaching-learning environments, and teaching-learning models. A Likert five-point scale questionnaire, or Questionnaire II, was used to assess the experts' responses during the second round (see Appendix D). The replies were combined to determine any patterns or distinctions. Most of the 17 experts agreed based on the similarities, although there were disagreements as well. The diagrams in Figures 4.1 to 4.8 are the end result of the synthesis of similarities and contrasts.

4.1.3 Third Round: Re-Evaluation

In the third phase, items from the results of Questionnaire II were used to reevaluate Objective 1: to synthesize learning process theories relevant to blended collaborative knowledge construction learning in vocational education. The three psychology theories—Gagné theory, constructivism, and constructionism—were used to inform the principles, teaching-learning activities/strategies, teaching-learning environments, and teaching-learning models that emphasize mental processes, learning

by doing, and social context. According to Table 4.5, the 17 experts were required to answer "yes" or "no" to question III.

4.1.4 **Fourth Round: Resolved and Reported**

The workable concepts had been located, dealt with, and reported by the fourth round. Both Appendix F and Table 4.6, which are both included with Questionnaire IV, contain these answers. All of the group members' viewpoints were accepted by the experts along with their ideas, tactics, and execution specifics. To put it another way, it offered the teachers' perspectives on the applicability of blended, collaborative knowledge-creation learning in vocational education.

4.2 Analysis Results

4.2.1 Objective 1: To Synthesize Learning Process Theories Related to blended collaborative knowledge construction learning in vocational education.

Here is a concise step-by-step guide on how to design the synthesis of learning process theories related to blended collaborative knowledge construction in vocational education:

4.2.1.1 Select Relevant Learning Theories: Choose learning process theories that align with blended collaborative knowledge construction, such as constructivism, social constructivism, and constructionism. The framework based on the theories shows the outcomes of the interviews or the first round of brainstorming, and these also contained elements of the learning process as stated in Objective 1 as follows:

Selecting appropriate learning process theories is a crucial first step in designing the synthesis of blended collaborative knowledge construction. This step involves carefully considering theories that are aligned with the goals and characteristics of vocational education. In particular, the theories of constructivism, social constructivism, and constructionism are well-suited for this context.

Gagné's theory of mental processes is made up of nine principles, four teaching-learning environments, three stages of teaching-learning activities, and seven teaching-learning model components. For instance, the principles mention igniting and controlling interests, as well as informing learners of the expected learning outcomes; teaching-learning environments mention instructors igniting and responding to students' behaviors; stages of teaching-learning activities mention igniting and controlling interests, as well as forming situations that will entice students to be interested in developing new ways of thinking.

Constructivism: This theory emphasizes that learners actively construct their understanding of the world based on their prior knowledge and experiences. In the context of vocational education, constructivism suggests that learners should engage in hands-on activities, problem-solving tasks, and collaborative projects to build their knowledge and skills. The emphasis on active engagement resonates with the idea of blended collaborative knowledge construction, as students work together to construct knowledge through real-world applications. Constructivism, which uses a learning-by-doing methodology, is composed of nine principles, four teaching-learning environments, three stages of teaching-learning activities, and seven teaching-learning model components. To activate pre-knowledge, for instance, teaching-learning environments refer to the surroundings of instructors and students as well as knowledge resources. Stages of teaching-learning activities refer to the activation of pre-knowledge, and principles refer to learners checking previous knowledge before

learning new things. Their instructors use a teaching method called the learning cycle to encourage learners to ask questions that require thinking.

Social Constructivism: Social constructivism builds upon constructivism by highlighting the importance of social interaction and collaboration in learning. In vocational education, students often learn from each other's experiences and expertise. This theory suggests that meaningful learning occurs when learners engage in joint activities, discussions, and peer feedback. Blended collaborative knowledge construction naturally aligns with this theory by fostering a collaborative environment where students share their insights and co-construct knowledge. Eight principles, four teaching-learning environments, four stages of teaching-learning activities, and seven teaching-learning models make up constructionism based on social context. Teaching-learning environments, on the other hand, refer to teachers, students, environments, and knowledge resources; stages of teaching-learning activities, on the other hand, refer to motivating learning, activating pre-knowledge, and changing thinking; and teaching-learning models, on the other hand, refer to brainstorms for project-based learning, students planning the project, and so on.

Connectivism: As a theory suitable for the digital age, connectivism acknowledges the role of technology and networks in learning. It suggests that learners should be adept at navigating and utilizing information from various sources. In blended collaborative knowledge construction, students engage in online discussions, research, and information sharing, aligning well with Connectivism principles.

When selecting these learning theories, it's essential to consider their compatibility with vocational education's practical and hands-on nature. The nature of vocational education often involves skill development and real-world application, making the selected theories valuable in guiding the creation of a synthesis that emphasizes collaborative knowledge construction.

Furthermore, the combination of these theories acknowledges the diverse learning needs of vocational education students. They accommodate different learning styles, provide opportunities for active participation, and promote a sense of ownership over the learning process.

In summary, the process of selecting learning theories involves a deliberate consideration of theories like constructivism, social constructivism, and Connectivism, which align with vocational education's characteristics and the objectives of blended collaborative knowledge construction. This selection provides a solid foundation for designing a comprehensive learning model that fosters collaborative knowledge construction among vocational education students.

4.1.1.2 Identify Key Principles: Extract core principles and strategies from each selected learning theory that are applicable to blended collaborative knowledge construction. These could include active participation, peer interaction, and real-world application.

Once relevant learning theories like constructivism, social constructivism, and Connectivism have been selected, the next step is to identify the core principles and strategies from each theory that can contribute to the development of the blended collaborative knowledge construction model for vocational education.

Constructivism Principles: From constructivism, key principles such as active learning, problem-solving, and experiential learning are paramount. Active participation

is vital in engaging students directly in the learning process. In the context of blended collaborative knowledge construction, active learning can manifest through collaborative projects, discussions, and hands-on tasks. Problem-solving strategies promote critical thinking, encouraging students to explore solutions collectively. Additionally, the emphasis on experiential learning aligns with the practical nature of vocational education, where students learn by doing.

Social Constructivism Principles: Social constructivism emphasizes the importance of social interaction and peer collaboration. Peer interaction becomes a cornerstone principle, encouraging students to share their perspectives, insights, and experiences. This interaction can occur through online discussions, group projects, and collaborative problem-solving. By engaging in peer interactions, students learn from each other and co-construct knowledge, which resonates with the collaborative knowledge construction approach.

Connectivism Principles: Connectivism's principles of networked learning and utilizing technology align well with the blended aspect of the model. In a digitally connected world, students can access a wealth of information from various sources. Utilizing technology tools for research, communication, and information sharing becomes crucial. This principle reinforces the notion that learning extends beyond the classroom and involves navigating a networked environment.

In summary, the identification of key principles from selected learning theories involves distilling essential elements like active participation, peer interaction, and real-world application. These principles will shape the subsequent design of the blended collaborative knowledge construction model, ensuring its relevance and effectiveness in vocational education settings.

4.1.1.3 Identify Commonalities: Identify common elements and principles shared among the selected learning theories. These shared aspects will serve as the foundation for the synthesis.

As a critical step in the synthesis process, identifying common elements and principles shared among the selected learning theories plays a pivotal role in creating a cohesive and effective blended collaborative knowledge construction model.

Active Participation: One commonality that stands out across constructivism, social constructivism, and Connectivism is the emphasis on active participation. All three theories advocate for learners to be actively engaged in their learning process. Whether it's through hands-on activities, collaborative discussions, or interactions with online resources, active participation ensures that learners are not passive recipients but active contributors to their knowledge construction.

Peer Interaction and Collaboration: Another significant commonality is the emphasis on peer interaction and collaboration. Social constructivism places a strong emphasis on the role of social interaction in learning, while Connectivism highlights the importance of networked learning. Collaborative activities, group projects, and peer feedback are shared practices that enable learners to engage with their peers, share insights, and collectively construct knowledge.

Real-World Application: All three theories recognize the value of real-world application in learning. Constructivism's focus on problem-solving, social constructivism's contextual learning, and connectivism's emphasis on leveraging real-world resources align with the practical nature of vocational education. Learning

becomes more meaningful when students can apply their knowledge to authentic scenarios, reinforcing the common principle of real-world application.

Technology Integration: In an era driven by technology, the integration of digital tools is a shared aspect. Connectivism explicitly underscores the role of technology in networked learning, while constructivism and social constructivism encourage the use of technology to enhance learning experiences. Blending traditional and online learning environments capitalizes on this commonality, enabling students to access resources, collaborate, and engage beyond the classroom.

Identifying these commonalities among the selected learning theories provides a solid foundation for synthesizing a blended collaborative knowledge construction model. By integrating active participation, peer interaction, real-world application, and technology, educators can design learning experiences that leverage the strengths of multiple theories.

4.1.1.4 Expert Validation: Seek validation and feedback from vocational education experts, educators, and practitioners. Their insights will help ensure the relevance and effectiveness of the synthesized model.

In the process of synthesizing learning process theories for blended collaborative knowledge construction in vocational education, seeking validation and feedback from vocational education experts, educators, and practitioners is a crucial step to ensure the model's relevance, effectiveness, and practicality.

Relevance to Vocational Context: Vocational education operates within specific contexts that require tailored approaches. By involving experts from the vocational education field, you can ensure that the synthesized model aligns with the unique demands and requirements of vocational training. Their insights can shed light on how the model can be adapted to address the specific needs of vocational learners and industries.

Pedagogical Soundness: Educators who have experience in vocational education possess valuable insights into effective pedagogical strategies. Engaging them in the validation process allows for a comprehensive assessment of the synthesized model's instructional design, learning activities, and assessment methods. Their feedback can highlight areas where adjustments are needed to enhance the model's pedagogical soundness.

Practical Implementation: Practitioners, such as vocational trainers and instructors, offer a practical perspective on implementing educational models. Their input can identify potential challenges, suggest modifications for seamless integration, and provide recommendations for optimizing the model's implementation in real-world vocational classrooms. This feedback is essential to ensure the model's practicality and feasibility.

Alignment with Learning Outcomes: Vocational education aims to equip students with practical skills and competencies. Engaging experts can help validate whether the synthesized model effectively aligns with desired learning outcomes. Their expertise can verify whether the learning activities and collaborative approaches embedded in the model contribute to the development of relevant vocational skills.

Continuous Improvement: Expert validation is not only about approval but also about continuous improvement. Feedback from experts provides a basis for iterative refinement of the synthesized model. By incorporating their suggestions, the

model can evolve to better address emerging trends, technologies, and changes in the vocational education landscape.

Incorporating expert validation and feedback is essential to ensure that the blended collaborative knowledge construction model is well-informed, robust, and attuned to the needs of vocational learners. By engaging with experts, you are not only enhancing the model's quality but also fostering a collaborative approach that draws from the collective wisdom of professionals in the field.

4.1.1.5 Create an Integrated Framework: Develop a new framework that integrates the identified common elements from different learning theories. This framework should illustrate how these elements contribute to blended collaborative knowledge construction.

Once the common elements and principles from different learning theories have been identified, the next step is to craft an integrated framework that visually represents how these elements synergistically contribute to blended collaborative knowledge construction in vocational education. This framework serves as a roadmap that guides educators and instructional designers in effectively structuring their instructional strategies.

Element Mapping: Begin by mapping the identified common elements onto the framework. Each element should be positioned in a way that showcases its relevance to the overall process of blended collaborative knowledge construction. This visual mapping provides a clear overview of the integral components that shape the learning experience.

Sequencing and Flow: Arrange the elements in a logical sequence that reflects the flow of the learning process. For example, if active participation is a common element, it could be positioned at the initial stage of the framework to emphasize its role in engaging learners right from the start. Sequencing the elements helps create a coherent narrative of how they build upon each other.

Interconnections: Highlight the interconnections and relationships between the elements. This can be achieved through arrows, lines, or other visual cues that demonstrate how certain elements influence or complement others. For instance, peer interaction might connect with real-world applications to emphasize how collaboration leads to practical skill development.

Learning Journey: Design the framework as a learning journey that guides learners through various phases of blended collaborative knowledge construction. Each element represents a distinct aspect of the learning process, and their arrangement should depict a holistic and progressive journey that learners undertake.

Supporting Elements: In addition to the common elements, consider including supporting factors such as technology integration, assessment methods, and resources. These elements enrich the framework by providing a comprehensive view of the elements that enhance the learning experience.

Visual Representation: Design the framework in a visually appealing manner. Incorporate colors, icons, and typography that resonate with the vocational education context and promote engagement. A well-designed framework is not only informative but also visually captivating for educators and learners.

Flexibility and Adaptability: Ensure that the framework is flexible enough to accommodate variations in teaching approaches, learning contexts, and vocational

disciplines. The goal is to provide a versatile guide that can be adapted to different scenarios while retaining the core principles of blended collaborative knowledge construction.

By creating an integrated framework, educators gain a holistic perspective on how different learning theories' common elements synergize to foster blended collaborative knowledge construction. This framework becomes a tangible tool that instructional designers can refer to when planning learning activities, structuring assessments, and orchestrating collaborative interactions. Ultimately, the integrated framework serves as a guiding beacon that empowers educators to facilitate effective blended collaborative learning experiences in vocational education settings.

In conclusion, the design process involves a systematic approach of selecting, extracting, integrating, and refining key principles from various learning theories to develop a comprehensive blended collaborative knowledge construction model tailored for vocational education.

It was necessary for the experts to determine the interview for developing Questionnaire I (Appendix C) in order to integrate the psychology theories focused on Gagné's theory (mental process), constructivism (learning by doing approach), and constructivism (social context) from the outcomes of this first round into the framework of an instructional model. Gagné's theory, constructivism, and constructionism all have a four-part conceptual structure. Principles, teaching-learning activities/strategies, teaching-learning environments, and a teaching-learning model were among them. Tables 4.1 to 4 display them and discuss them in the section below.4.

Table 4.1 Questionnaire I: The result of experts' opinions of principles

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Gagné's theory (mental processes)	1. Instructors create teaching criteria to suit the learners' external conditions.	4.53	Strongly agree	.62	2	Incongruence
	2. Instructors promote learning events.	4.12	Moderately agree	.78	2	Incongruence
	3. Instructors develop criteria according to step-by-step experience.	4.06	Moderately agree	.75	2	Incongruence
	4. Instructors use teaching procedures that have suitable systems, regulations, and elasticity.	4.82	Strongly agree	.39	1	Congruence
	5. Instructors create Organizational knowledge from experience.	4.59	Strongly agree	.51	1	Congruence
	6. Learners can learn effectively if instructional situations are formulated.	2.18	Disagree	1.24	4	Incongruence
	7. Learners should have basic knowledge at a comprehensive level and be able to solve problems.	2.06	Disagree	1.20	4	Incongruence
	8. Learners abilities consist of creative thinking, reflexive thinking, and thinking initiative.	4.06	Moderately agree	.75	2	Incongruence

Table 4.1 Questionnaire I: The result of experts' opinions of principles (Cont.)

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Constructivism (learning by doing)	1. Learners check previous knowledge before learning new things.	4.29	Moderately agree	.59	2	Incongruence
	2. Instructors use a teaching method which is called the learning cycle to encourage learners to ask questions that require thinking and stimulate learners to exchange opinions.	4.35	Moderately agree	.49	1	Congruence
	3. Learners learn by creating the meaning of things and checking their understanding.	4.47	Moderately agree	.51	1	Congruence
	4. Learners emphasize a child-centered model of self-controlled learning.	4.35	Moderately agree	.49	1	Congruence
	5. Instructors create the learning atmosphere.	3.12	Neutral	1.36	4	Incongruence
	6. Learners 'self-Knowledge' should be developed according to their competence and previous experience.	4.59	Strongly agree	.51	1	Congruence
	7. Learners should solve problems or investigate them in order to reduce contradictions in ideas which are important for learners to assimilate.	2.71	Neutral	1.40	4	Incongruence

Table 4.1 Questionnaire I: The result of experts' opinions of principles (Cont.)

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Constructivism (learning by doing)	8. Learners create a body of discovery knowledge through procedures.	4.59	Strongly agree	.51	1	Congruence

	9. Learners use knowledge which has already been learned.	4.35	Moderately agree	.49	1	Congruence
Constructionism (social context)	1. Learners create learning using their wit.	2.53	Neutral	1.38	4	Incongruence
	2. Learners learn by practicing or building up skills.	4.24	Moderately agree	.44	1	Congruence
	3. Learners create organizational knowledge on their own and not from instructors.	2.88	Neutral	1.27	4	Incongruence
	4. Learners exchange ideas, encourage one another, and correct the mistakes of one another.	2.53	Neutral	1.38	4	Incongruence
	5. Learners link ideas to help create the meanings of the things to be learned.	4.35	Moderately agree	.49	1	Congruence
	6. Learners analyze learning procedures, present their ideas and exchange them with one another.	2.88	Neutral	1.27	4	Incongruence

Table 4.1 Questionnaire I: The result of experts' opinions of principles (Cont.)

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Constructionism (social context)	7. When learning new things, learners should have teacher support in creating concrete examples that help them to gradually develop themselves to be experts in learning, and to be able to choose the thinking models that are most suitable for themselves.	4.24	Moderately agree	.44	1	Congruence
	8. Construct experiences through practical and problem solving with their instructors. Both learners and instructors work on one task together until they understand it completely.	4.59	Strongly agree	.51	1	Congruence

Note: M= Mean (1.00 – 1.49 = Strongly disagree; 1.50 – 2.49 = Disagree; 2.50 – 3.49 = Neutral; 3.50 – 4.49 = Moderately agree; 4.50 – 5.00 = Strongly agree); SD = Standard Deviation; IQR = Interquartile Range (IQR< 0.50 ≥ 1.00 = Congruent; IQR>1.00 = Incongruent)

From Table 4.1: The majority of experts strongly concurred with Gagné's theory (mental processes) on the following tenets: instructors use teaching procedures with appropriate systems, regulations, and elasticity; instructors develop organizational knowledge from experience; instructors create learning criteria to suit the learners' external conditions. They also had a fair amount of disagreements about how teachers encourage learning events, how teachers develop criteria based on step-by-step experience, and how learners' talents include creative thinking, reflexive thinking, and thinking initiatives. The majority of specialists argued that students may learn efficiently if instructional scenarios are created; rather, they believed that students should possess fundamental information at a thorough level and be able to solve problems. The majority of experts firmly believed that learners may learn effectively provided instructional circumstances are established and that learners should have fundamental knowledge at a comprehensive level and be able to solve issues. This is known as constructivism (learning by doing approach). However, the majority of experts were only partially in agreement that teachers should set the tone for learning

and that students should work through issues or look into them to eliminate conflicts in concepts that are crucial for them to assimilate. The majority of experts expressed no opinion on whether teachers should set up a learning environment or whether students should examine problems in order to lessen conflicts in concepts that are crucial for students to assimilate. Regarding constructionism (social context), the majority of experts strongly supported the idea that learners should construct experiences through hands-on activities and problem-solving with their instructors and that both parties should collaborate on a task until everyone involved understands it. When it comes to constructionism (social context), the majority of experts were somewhat in agreement that students should practice or develop their skills, link ideas to help create the meanings of the things they are learning, have support from teachers in creating concrete examples that will help them gradually develop into learning experts, and be a part of a community of learners. The majority of experts were unconcerned about how students use their wit to learn, how they develop organizational knowledge independently of teachers, how they share ideas and support one another, and how they correct one another's errors.

Table 4.2 Questionnaire I: The result of experts' opinions of teaching-learning activities / strategies

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Gagné′s theory (mental processes)	1. Stimulate and control interests.	4.76	Strongly agree	.44	1	Congruence
	2. Inform the expected learning outcomes to the learners.	2.88	Neutral	1.36	4	Incongruence
	3. Create situations to encourage learners to be interested in creating ways of thinking.	2.94	Neutral	1.09	4	Incongruence

Table 4.2 Questionnaire I: The result of experts' opinions of teaching-learning activities / strategies (Cont.)

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
	4. Give useful advice in learning.	4.94	Strongly agree	.24	1	Congruence
	5.Feedback management.	3.12	Neutral	1.41	4	Incongruence
	6. Assess practice.	4.76	Strongly	.44	1	Congruence

			agree			
	7. Arrange his/her learning to be transformed to the new one.	4.94	Strongly agree	.24	1	Congruence
	8.Create opportunities for memorization.	2.47	Neutral	1.13	4	Incongruence
	9. Transfer.	4.94	Strongly agree	.24	1	Congruence
Constructivism (learning by doing approach)	1.Activate pre-knowledge.	4.76	Strongly agree	.44	1	Congruence
	2. Find and select questions.	4.47	Moderately agree	.51	1	Congruence
	3. Knowledge transfer.	4.94	Strongly agree	.24	1	Congruence
Constructionism (social context)	1. Motivate learning.	3.18	Neutral	1.29	4	Incongruence
	2. Activate pre-Knowledge.	4.29	Moderately agree	.47	1	Congruence
	3. Change thinking.	3.12	Neutral	1.32	4	Incongruence
	4. Transfer thinking.	2.59	Neutral	1.46	4	Incongruence

Note: M= Mean (1.00 – 1.49 = Strongly disagree; 1.50 – 2.49 = Disagree; 2.50 – 3.49 = Neutral; 3.50 – 4.49 = Moderately agree; 4.50 – 5.00 = Strongly agree); SD = Standard Deviation; IQR = Interquartile Range (IQR< 0.50 ≥ 1.00 = Congruent; IQR>1.00 = Incongruent)

From Table 4.2: The majority of professionals firmly supported Gagné's thesis (mental processes) on how to stimulate and moderate interests, provide helpful learning suggestions, evaluate practice, organize learning so that it transforms into new learning, and transfer thinking. Additionally, they created circumstances that would stimulate learners' interest in developing new ways of thinking, managed feedback, and provided opportunities for memory while remaining neutral towards the desired learning outcomes for the students. The majority of experts moderately agreed on the learning-by-doing strategy that required retrieving and choosing the questions, while the majority strongly agreed with constructivism (learning-by- doing approach) on the stages of teaching-learning activities including activation pre-knowledge and knowledge transfer. According to constructionism (social context) on teaching-learning stages, the majority of experts were only marginally in agreement with the stage of activating prior knowledge. On the other hand, the majority of experts were ambivalent about the social environment's ability to motivate learning, alter thinking, and transfer thinking.

Table 4.3 Questionnaire I: The result of experts' opinions of teaching-learning environments

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Gagné's theory (mental processes)	1. Instructors.	4.53	Strongly agree	.51	1	Congruence
	2. Learners.	4.29	Moderately agree	.47	1	Congruence
	3. Stimulations.	2.59	Neutral	1.46	4	Incongruence
	4. Response behaviors.	2.65	Neutral	.70	2	Incongruence
Constructivism (learning by doing approach)	1. Instructors.	4.71	Strongly agree	.47	1	Congruence
	2. Learners.	4.71	Strongly agree	.47	1	Congruence
	3. Surroundings.	2.24	Disagree	.97	2	Incongruence
	4. Knowledge resources.	2.59	Neutral	1.46	4	Incongruence

Table 4.3 Questionnaire I: The result of experts' opinions of teaching-learning environments(Cont.)

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Constructionism(social context)	1. Instructors	4.47	Strongly agree	.51	1	Congruence
	2. Learners	4.47	Strongly agree	.51	1	Congruence
	3. Surroundings	2.35	Disagree	1.22	4	Incongruence
	4. Knowledge Resources	2.88	Neutral	1.36	4	Incongruence

Note: M= Mean (1.00 – 1.49 = Strongly disagree; 1.50 – 2.49 = Disagree; 2.50 – 3.49 = Neutral; 3.50 – 4.49 = Moderately agree; 4.50 – 5.00 = Strongly agree); SD = Standard Deviation; IQR = Interquartile Range (IQR< 0.50 ≥ 1.00 = Congruent; IQR>1.00 = Incongruent)

From Table 4.3: Most experts strongly agreed with learning environments in that teachers adopted Gagné's theory (mental processes), constructivism (learning by doing approach), and constructionism (social context) in their assessments of various psychological theories. The findings also demonstrated that students accept constructionism (social context) and constructivism (learning by doing). On the other hand, they were only slightly in agreement that students accept constructivism (an approach that emphasizes learning by doing) and constructionism (social context), as well as Gagné's theories of mental processes and knowledge resources, and that they are neutral on stimulation. Most professionals have mixed feelings about knowledge resources. They disagreed on environments that support both constructionism (social context) and constructivism (learning by doing approach).

Table 4.4 Questionnaire I: The result of experts' opinions on the teaching-learning models

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Gagné's theory (mental processes)	1. Signal learning.	4.76	Strongly agree	.44	1	Congruence
	2. Chaining.	4.65	Strongly agree	.49	1	Congruence

Table 4.4 Questionnaire I: The result of experts' opinions on the teaching-learning models(Cont.)

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Gagné's theory (mental processes)	3. Verbal association.	4.94	Strongly agree	.24	1	Congruence
	4. Discrimination learning.	4.94	Strongly agree	.24	1	Congruence
	5. Concept learning.	4.71	Strongly agree	.47	1	Congruence
	6. Rule learning.	4.65	Strongly agree	.49	1	Congruence
	7. Problem solving.	4.65	Strongly agree	.49	1	Congruence
	8. Creative thinking, reflective, thinking, and thinking initiatives.	4.65	Strongly agree	.49	1	Congruence
Constructionism (learning by doing	1. Self-learning. (simulation and games)	4.71	Strongly agree	.47	1	Congruence

approach)	2. Cooperative learning.	2.88	Neutral	1.36	4	Incongruence
	3. Project-based learning.	2.24	Disagree	.97	2	Incongruence
	4. Problem-based learning.	3.00	Neutral	1.17	4	Incongruence
	5. Situation learning.	4.53	Strongly agree	.62	2	Incongruence
	6. Group investigation.	2.59	Neutral	1.46	4	Incongruence
	7. Inquiry method.	3.00	Neutral	1.32	4	Incongruence

Table 4.4 Questionnaire I: The result of experts' opinions on the teaching-learning models(Cont.)

Main term	Questionnaire	M	Opinion of experts	SD	IQR	Consensus
Constructivism (social context)	1. Brainstorms for project based-learning.	4.53	Strongly agree	.62	2	Incongruence
	2. Planning their own learning.	4.53	Strongly agree	.62	2	Incongruence
	3. Sharing construction.	4.82	Strongly agree	.39	1	Congruence
	4. New knowledge.	4.53	Strongly agree	.62	2	Incongruence
	5. Presentation.	4.82	Strongly agree	.39	1	Congruence
	6. Learning assessment.	4.59	Strongly agree	.51	1	Congruence
	7. Modify actions.	4.94	Strongly agree	.24	1	Congruence

Note: M= Mean (1.00-1.49 = Strongly disagree; 1.50-2.49 = Disagree; 2.50-3.49 = Neutral; 3.50-4.49 = Moderately agree; 4.50-5.00 = Strongly agree); SD = Standard Deviation; IQR = Interquartile Range (IQR< 0.50 ≥ 1.00 = Congruent; IQR>1.00 = Incongruent)

From Table 4.4: The majority of professionals firmly agreed that the following mental processes have an impact on teaching-learning models: signals learning, chaining, linguistic association, discriminating learning, learning concepts, learning rules, problem-solving, and creative, reflective, and thinking initiatives. In terms of self-learning (simulation and games) and situational learning, the majority of experts firmly supported

the learning-by-doing approach in teaching-learning models. In terms of cooperative learning, project-based learning, problem-based learning, group investigations, and the inquiry method, the majority of experts were also unsupportive of the learning-by-doing approach. Cooperative learning, project-based learning, problem-based learning, group investigations, and inquiry methods were all strongly recommended for the social environment by the majority of experts. Additionally, the items were chosen by the researchers based on the results of questionnaire I. This indicates that the similarities and contrasts between the four terms—principles, teaching-learning activities/strategies, teaching-learning environments, teaching-learning models of mental processes, learning-by-doing approach, and social context—were pooled together. The 17 experts' opinions were divided, but the commonalities indicated that the majority of them were in agreement. Diagrams "show hierarchical relationships progressing horizontally [which] work well for decision trees" as a result of the synthesis of similarities and differences, according to Gultepe (Gultepe et al., 2007). Figures 4.1 to 4.8 display these.

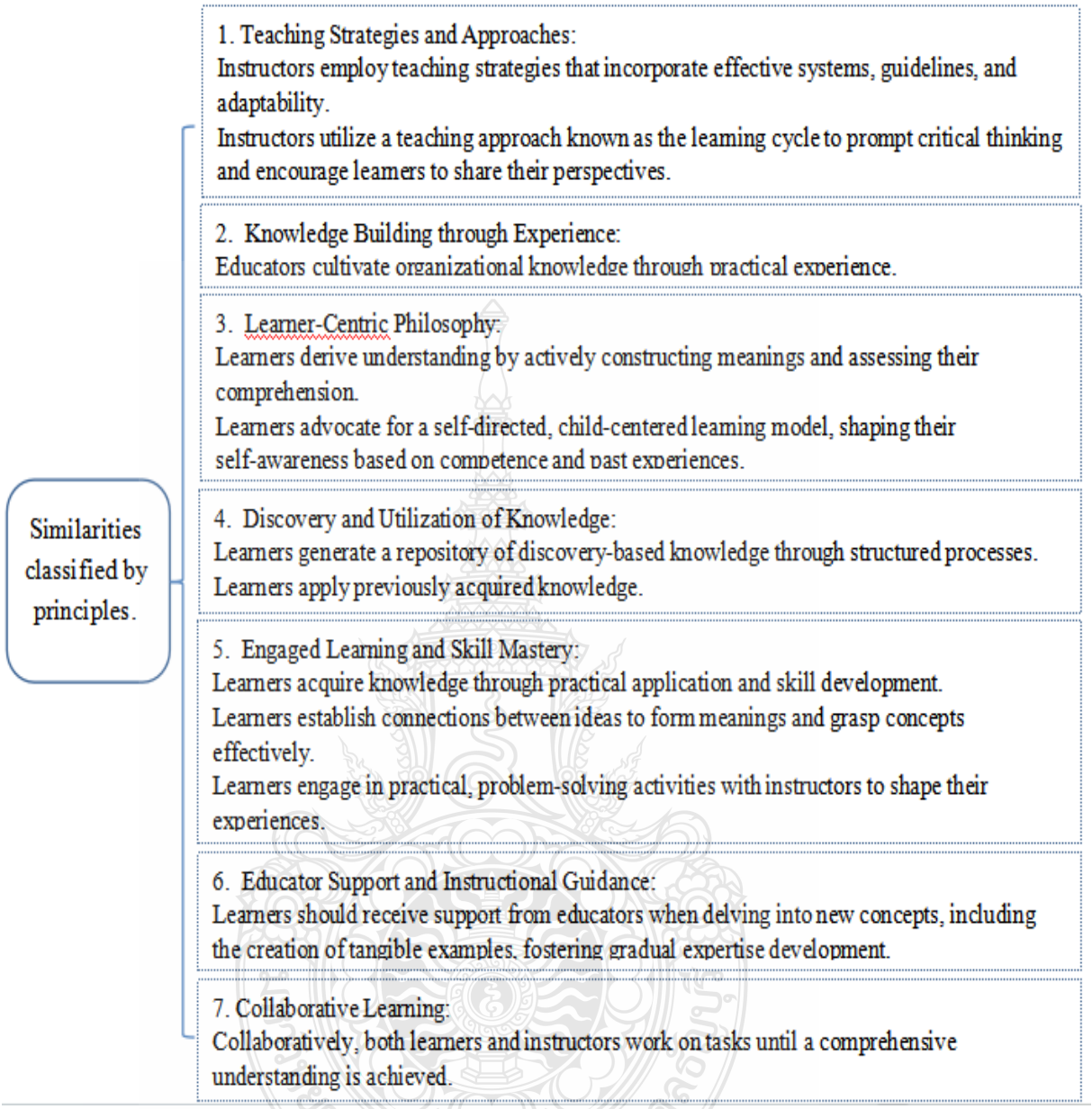

Figure 4.1 Similarities classified by principles

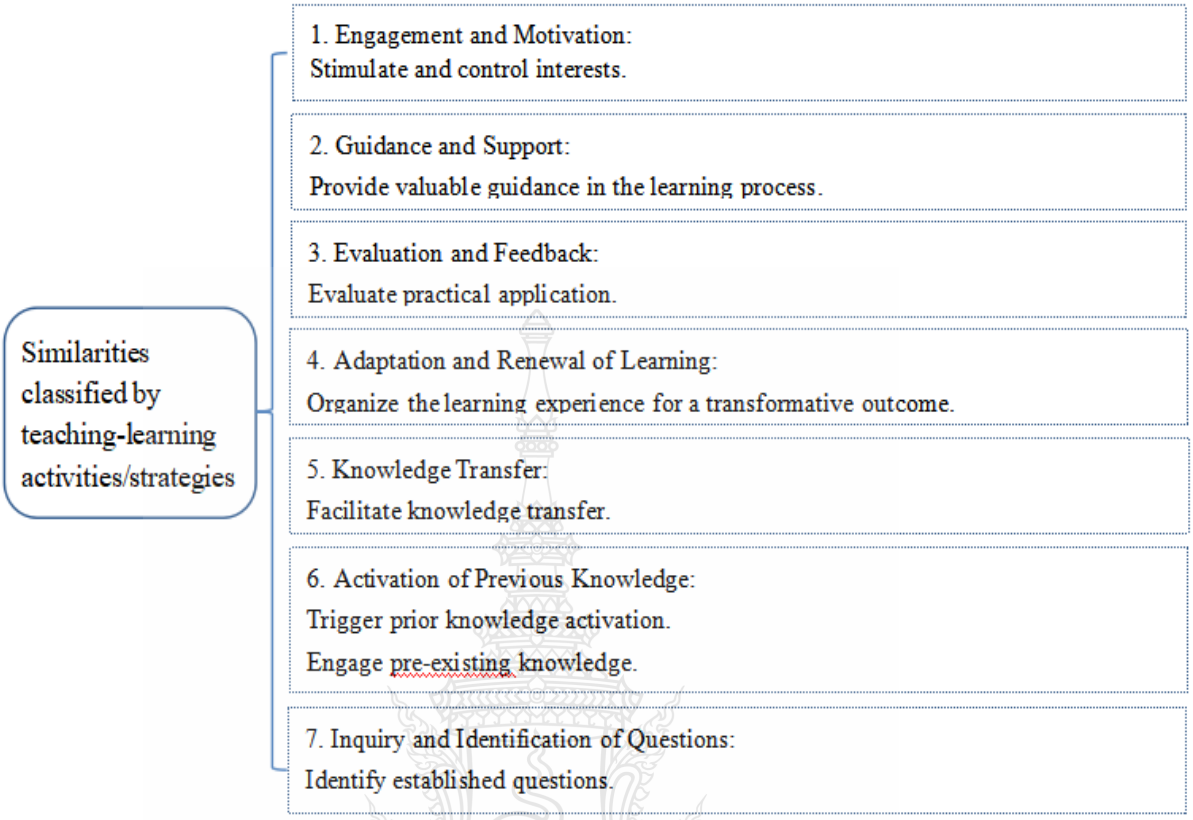

Figure 4.2 Similarities classified by teaching-learning activities/strategies

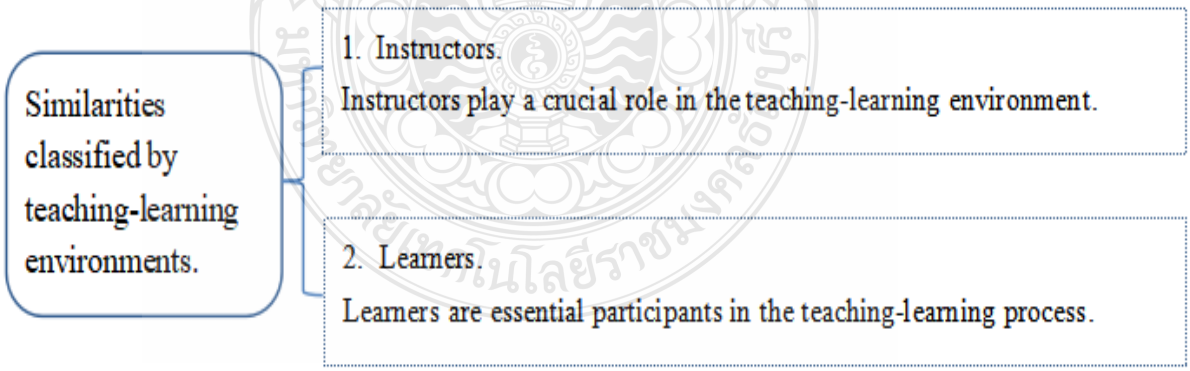

Figure 4.3 Similarities classified by teaching-learning environments

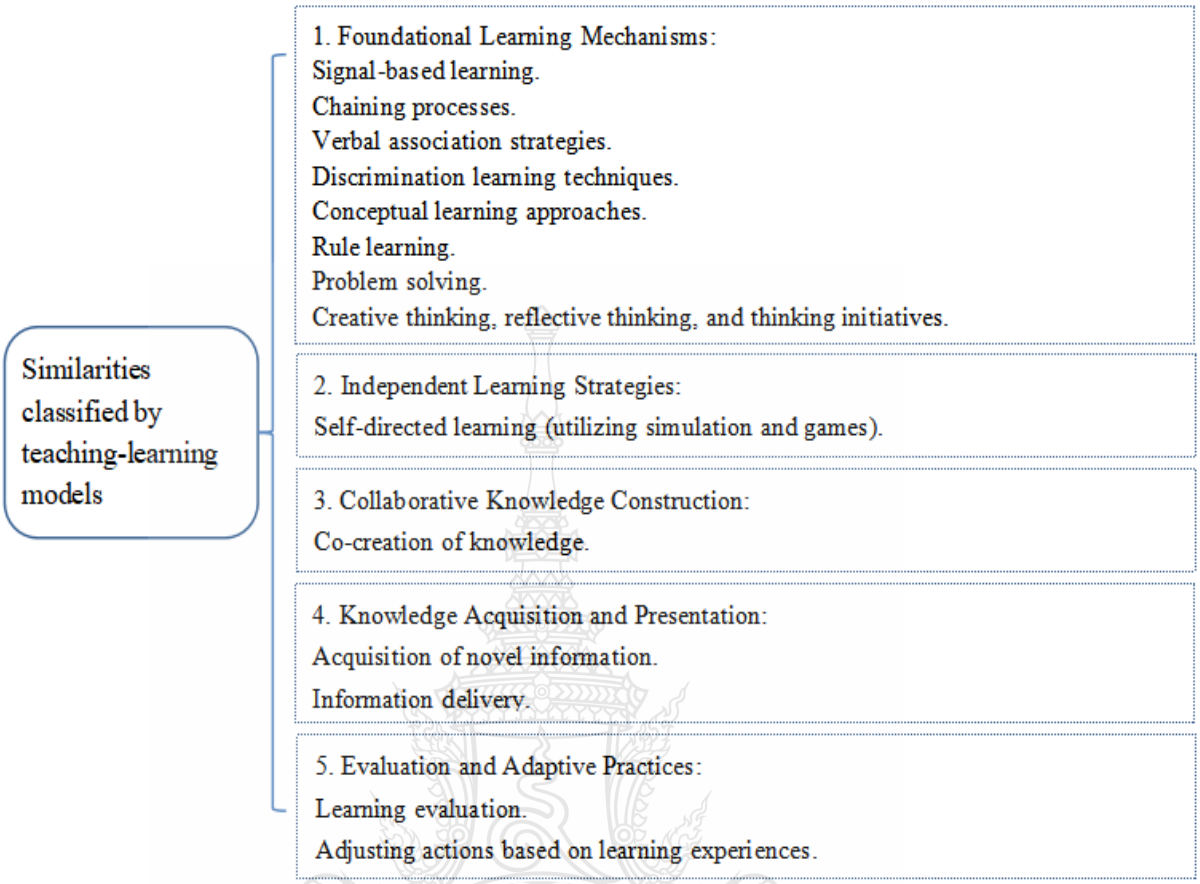

Figure 4.4 Similarities classified by teaching-learning models

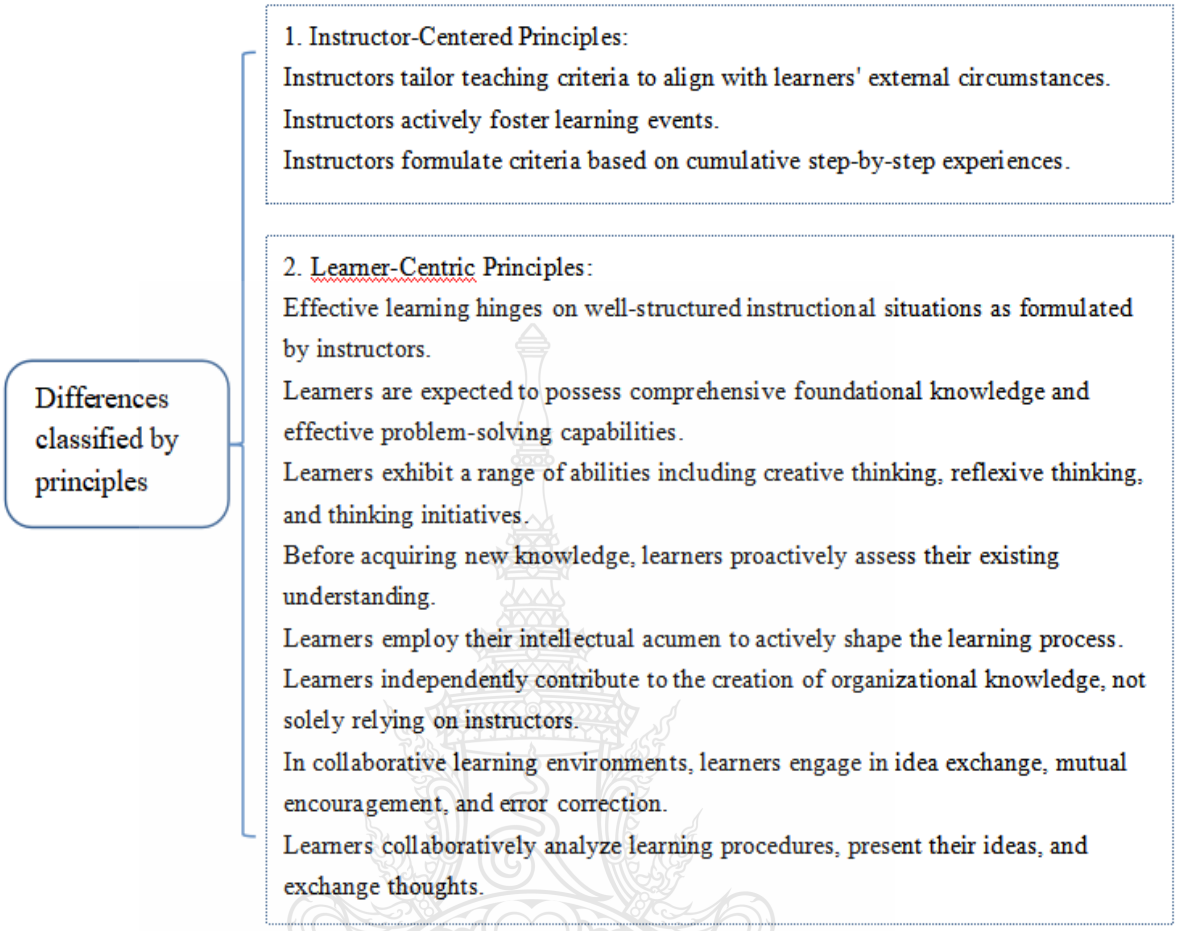

Figure 4.5 Differences classified by principles

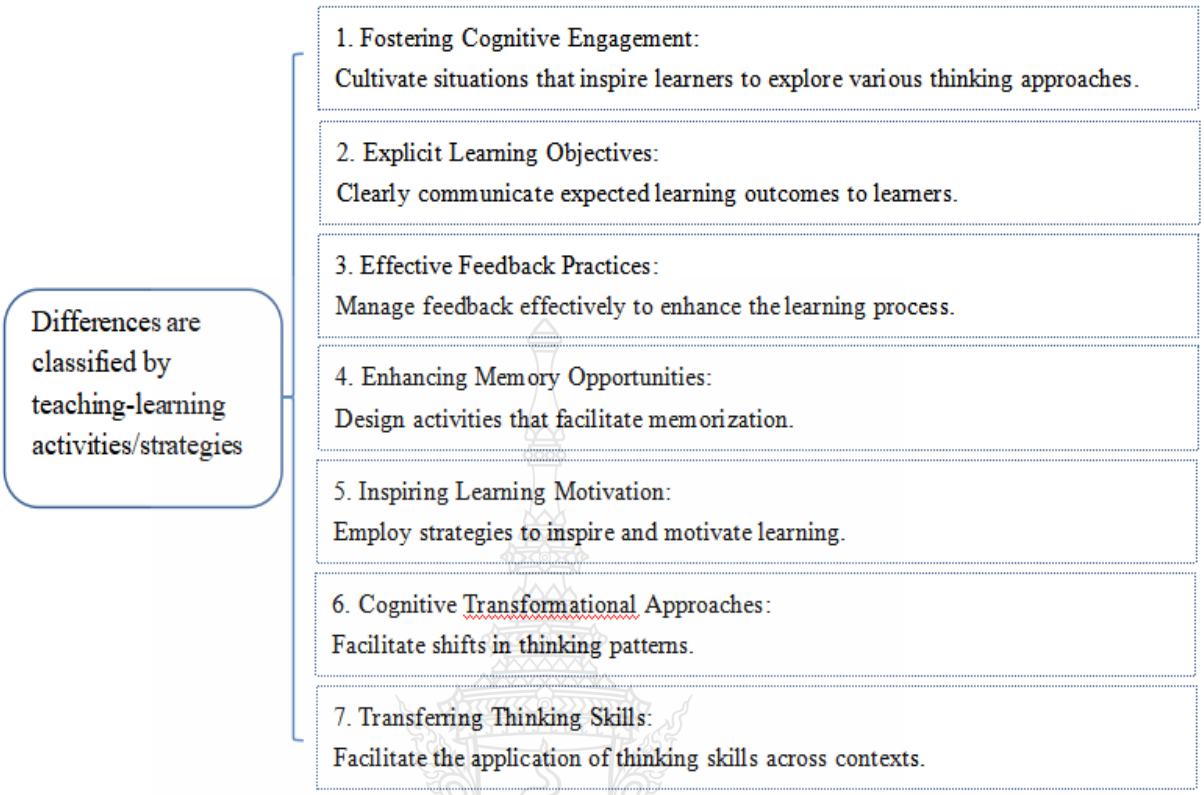

Figure 4.6: Differences classified by teaching-learning activities/strategies

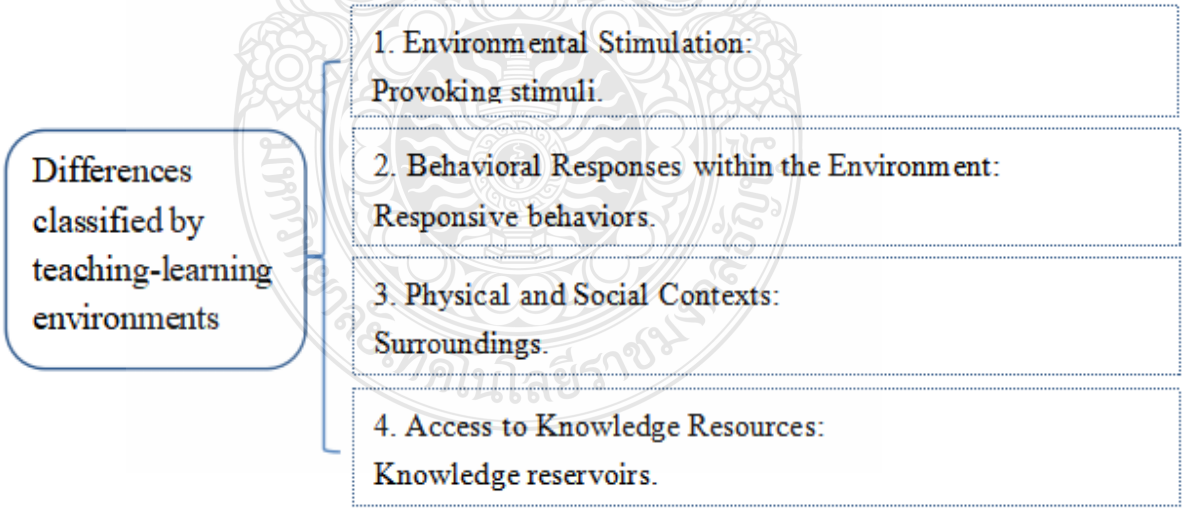

Figure 4.7 Differences classified by teaching-learning environments

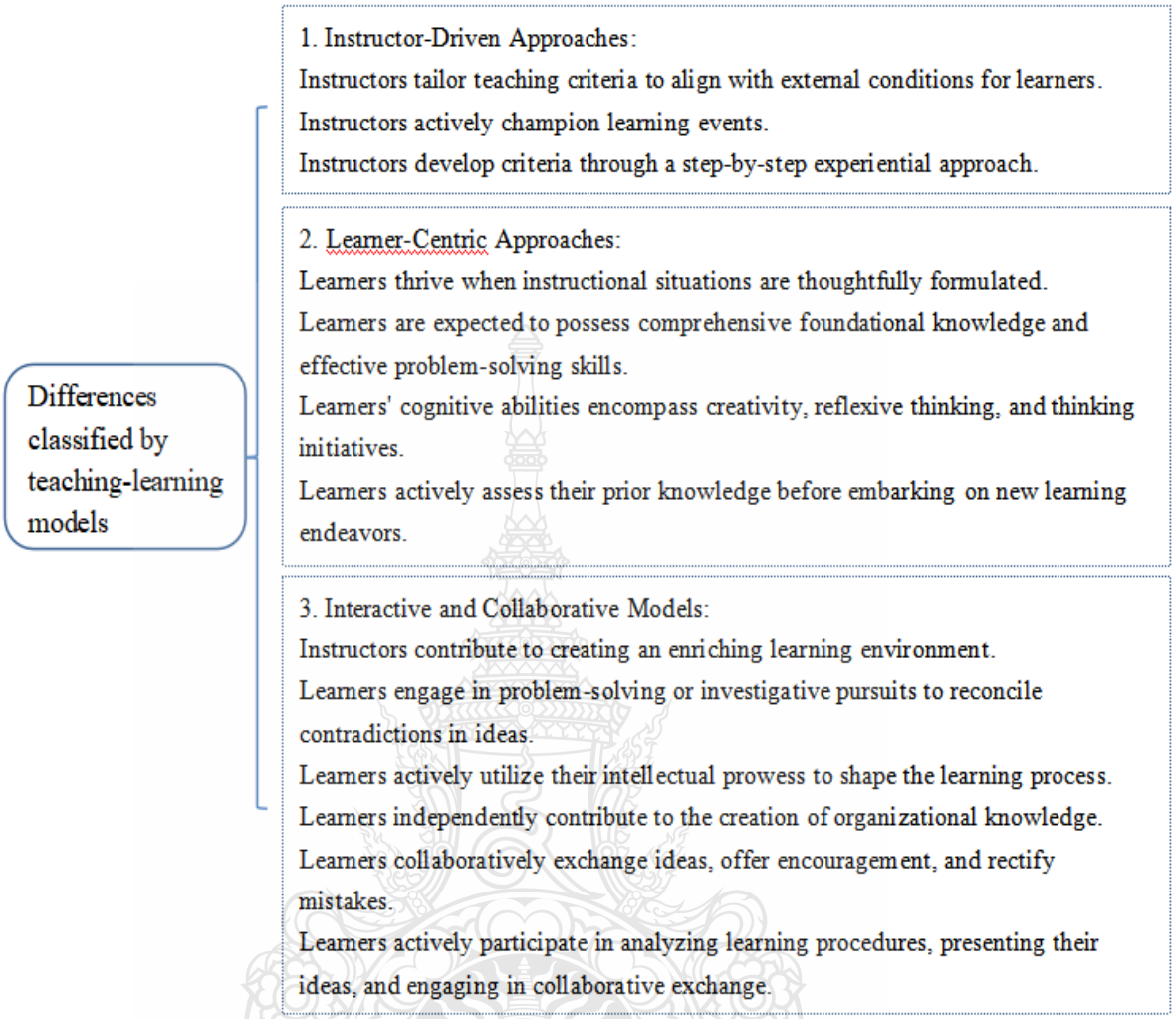

Figure 4.8 Differences classified by teaching-learning models

See diagrams 4.1 - 4.8. The 17 experts were required to respond “yes” or “no” to questionnaire III. The responses are shown in table 4.5.

Table 4.5 Questionnaire III: The result of 17 experts’ opinions concerning the relevance of using learning process theory to synthesize a blended collaborative knowledge construction learning model in vocational education.

No.	Principles	Yes Response Percentage	No Response Percentage	Unsure Response Percentage
a. Principles				
1	Creating situations and building experience by using concept maps.	83.0	13.2	3.8
2	Stimulating learners to learn by using music and images.	87.7	8.5	3.8
3	Creating an atmosphere suitable for exchanging opinions by using social media for instruction.	62.3	28.3	9.4
4	Linking learners’ ideas by using hyperlinks.	58.5	26.4	15.1
5	Creating experiences for learning new things before teaching new content.	75.5	5.7	18.8
6	Activating pre-knowledge of oneself through entry examination, participation in games/activities, and questioning.	86.8	9.4	3.8
7	Exchanging ideas and correcting mistakes through final examinations; answering, and chatting on bulletin boards.	55.7	37.2	7.1
8	Building bodies of knowledge through the steps of comprehension, memorization, analysis, and application by using supplementary activities and doing exercises after lessons.	52.8	30.2	17.0

Table 4.5 Questionnaire III: The result of 17 experts’ opinions concerning the relevance of using learning process theory to synthesize a blended collaborative knowledge construction learning model in vocational education (Cont.)

No.	Domains	Yes Response Percentage	No Response Percentage	Unsure Response Percentage
9	Creating creativity, reflective thinking,	83.1	9.4	7.5

	and initiating ideas by inventing a piece of work; summarizing and designing an invention.			
b. Teaching learning environments				
	The components of teaching-learning management are learners and instructors**.**	81.1	9.4	9.5
c. Teaching/learning activities/strategies				
1	Stimulating attention.	77.4	18.9	3.7
2	Activating prior-knowledge.	73.6	22.6	3.8
3	Informing the learners of expected outcomes.	88.7	9.4	1.9
4	Manipulating and stimulating conditions to gain attention.	86.8	9.4	3.8
5	Providing learning guidelines.	67.0	26	7
6	Searching for answers and exchanging knowledge.	92.5	5.7	1.8
7	Reflecting, memorizing, analyzing, and applying knowledge.	77.4	15.1	7.5
8	Learning through self-discovery.	82.0	9.0	9.0
d. Teaching learning models				
1	The term dependent learning means that learning is designed by instructors.			
	1.1 Drill-and-practice instruction.	54.7	17.0	28.3
	1.2 ‘Tests instruction’ means a series of test items to help students enhance learning.	73.6	17.0	9.4
	1.3 Games-based instruction is an example of dependent learning.	40.6	24.4	35.0

Table 4.5 Questionnaire III: The result of 17 experts’ opinions concerning the relevance of using learning process theory to synthesize a blended collaborative knowledge construction learning model in vocational education (Cont.)

No.	**Domains**	**Yes Response Percentage**	**No Response Percentage**	**Unsure Response Percentage**
2	Independent learning means learning is designed by students.			
	2.1 Collaborative learning and/or team-based learning.	77.4	9.4	13.2
	2.2 Project-based learning is an example of independent learning.	75.5	13.2	11.3
	2.3 Group process learning is an example of independent learning.	71.7	13.2	15.1

From Table 4.5: The table shows the consensus among the 17 experts on a few key psychological theories, including constructivism (learning by doing), Gagné's theory of mental processes, and constructionism (social context). All three theories are categorized by teaching-learning models as focusing on mental processes, learning by doing, and social environment. The study included the opinions of the majority of experts regarding electronics media development in accordance with an instructional model of learning process theories for blended collaborative knowledge construction learning in vocational education, and the majority of experts strongly agreed with Gagné's theory on teaching-learning models. The outcomes are categorized below.

a. *Principles*. The percentage of affirmative responses was 71.71%, the percentage of negative responses was 18.70%, and the percentage of doubtful responses was 9.60%. Examples include setting up scenarios and developing experiences using concept maps, motivating students to learn through the use of music and images, fostering an environment conducive to discussion through the use of social media during instruction, connecting students' ideas via hyperlinks, and developing learning opportunities prior to introducing new material. Exchanging ideas and fixing mistakes through final exams, answering, and conversing on message boards; activating pre-knowledge of oneself through involvement in games and activities, questioning, and entry exams; By using supplemental activities and exercises after the lessons, you can help students build their bodies of knowledge through the stages of comprehension, memorization, analysis, and application. You can also encourage creativity, reflective thinking, and idea initiation by having them create a piece of work, summarize it, and design an invention.

b.*Teaching-learning environments for learners and instructors*. The percentage of affirmative responses was 81.1%, the percentage of negative responses was 9.4%, and the percentage of doubtful responses was 9.5%.

c. *Teaching-learning activities/strategies*. The percentage of yes responses was 80.68%, the percentage of no responses was 14.51%, and the percentage of doubtful responses was 4.81%. Examples include: getting students' attention; getting them to use their prior knowledge; telling them what to expect; manipulating and stimulating the environment to get students' attention; giving them learning guidelines; getting them to ask questions and exchange knowledge; getting them to reflect, memorize, analyze, and apply what they have learned; and learning through self-discovery.

d. *Teaching-learning models*. "Dependent learning" refers to learning that is created by teachers; examples include drill-and-practice instruction, "tests instruction," which refers to a set of test questions designed to assist pupils in improving their understanding, and "games-based instruction." 'Independent Learning' refers to learning that is created by students (e.g., 'collaborative learning' and/or 'team-based learning'; 'project-based learning' is an example of independent learning; 'group process learning' is an example of independent learning). The percentage of affirmative responses was 65.58%, the percentage of negative responses was 15.70%, and the percentage of doubtful responses was 18.77%.

In Questionnaire IV and Table 4.6, the opinions of the 17 experts are summarized in relation to the necessity of identifying and creating a blended collaborative knowledge construction learning model for vocational education.

4.2.2 Objective 2: To identify and develop a Learning model using learning process theories for blended collaborative knowledge construction in vocational education.

Designing a learning model that integrates learning process theories for blended collaborative knowledge construction in vocational education involves a systematic and structured approach. Here's a step-by-step breakdown of the design process:

4.2.2.1 Define Learning Objectives: Clearly outline the learning objectives that align with the goals of blended collaborative knowledge construction in vocational education. These objectives should focus on developing students' collaborative skills, critical thinking, and domain-specific knowledge.

Defining precise and purposeful learning objectives forms a fundamental pillar in crafting an effective learning model tailored to the goals of blended collaborative knowledge construction within vocational education. These objectives serve as a compass, directing the trajectory of educational endeavors toward desired outcomes. In this context, the meticulously outlined learning objectives should be closely aligned with the overarching goals of vocational education. This alignment ensures that the learning experiences are intricately interwoven with the practical needs of the student's future professional pursuits. Notably, the objectives should holistically address the multifaceted dimensions of learning essential for a dynamic workforce. This encompasses fostering collaborative skills that empower students to thrive in collaborative environments, nurturing critical thinking faculties to enable them to analyze and synthesize information effectively, and cultivating domain-specific knowledge that directly translates to industry-relevant expertise.

By centering these objectives on the triad of collaborative skills, critical thinking, and domain-specific knowledge, the learning model demonstrates a strategic coherence that speaks directly to the demands of modern vocational education. This alignment presents students with a comprehensive educational journey where they not only accumulate knowledge but also develop the skill set demanded by today's professional landscape. As a result, the learning model becomes a conduit through which students are equipped not just with theoretical understanding but also with the practical acumen to excel in their chosen vocational paths.

4.2.2.2 Design Learning Activities: Create a variety of learning activities that engage students in collaborative knowledge construction. These activities could include group discussions, case studies, problem-solving tasks, and project-based assignments.

Crafting a diverse array of engaging learning activities lies at the heart of designing a dynamic learning model tailored to blended collaborative knowledge construction within the context of vocational education. These activities are the conduits through which students actively participate in the process of knowledge co-creation, fostering a deep sense of engagement and mastery. In this endeavor, the design of learning activities should be a judicious blend of innovation and alignment with the desired learning outcomes. Group discussions, for instance, can cultivate an environment where students share diverse perspectives and collectively construct insights. Case studies, on the other hand, offer opportunities for students to apply theoretical knowledge to real-world scenarios, bridging the gap between academia and industry practice. Problem-solving tasks stimulate cognitive agility, encouraging students to navigate intricate challenges and devise creative solutions. Project-based assignments encapsulate a holistic learning experience, enabling students to

collaboratively tackle complex problems while refining their collaboration, communication, and problem-solving skills.

The design of these activities should be guided by a pedagogical vision that nurtures both the individual growth of students and their collaborative prowess. Moreover, the activities should be thoughtfully scaffolded, catering to diverse learning styles and skill levels, thus ensuring an inclusive and effective learning experience. Ultimately, the deliberate selection and design of these activities transform the learning model into a vibrant ecosystem that nurtures collaborative knowledge construction and empowers students with the competencies essential for success in the professional realm.

4.2.2.3 Integrate Technology and Create Support Resources: Incorporate technology tools and platforms that facilitate blended learning and collaboration. This could include video conferencing, online discussion forums, collaborative documents, and virtual simulations. Develop resources that support both instructors and students in navigating the learning model. This could include guidelines for effective collaboration, technical support documents, and resources for further exploration.

Seamlessly infusing technology into the learning model is a pivotal step in harnessing the potential of blended collaborative knowledge construction within the realm of vocational education. This integration enlivens the learning experience, fostering a dynamic environment where learners engage with course content, peers, and instructors in novel ways. To achieve this, a well-considered array of technological tools and platforms can be employed. Video conferencing platforms enable synchronous interactions, offering students the chance to engage in real-time discussions and collaborative activities, despite physical barriers. Online discussion forums serve as virtual meeting points, facilitating asynchronous exchanges of ideas and promoting continuous engagement. Collaborative document platforms empower students to co-create knowledge and share insights, fostering a sense of shared ownership in the learning process. Virtual simulations provide immersive experiences that bridge theoretical concepts with practical applications, enhancing learners' grasp of complex subject matter.

In tandem with technology integration, the development of support resources is essential for ensuring a smooth and enriching learning journey for both educators and students. Faculty members benefit from guidelines for orchestrating effective collaboration, ensuring that their instructional strategies align with the collaborative learning model. Technical support documents equip instructors and students with the skills to navigate the digital landscape seamlessly, mitigating potential technical barriers. Moreover, resources for further exploration extend the learning experience beyond the classroom, enabling students to delve deeper into subjects of interest and broaden their horizons.

The amalgamation of cutting-edge technology and comprehensive support resources empowers educators to guide students through the intricacies of the blended collaborative knowledge construction model with confidence while providing students with the tools they need to thrive in a technology-rich learning environment.

4.2.2.4 Incorporate Assessment Strategies: Design assessment methods that align with the learning objectives and encourage students to demonstrate their collaborative

knowledge construction. Use formative assessments to provide ongoing feedback and summative assessments to evaluate learning outcomes.

A pivotal aspect of the development process is the careful integration of assessment strategies that resonate harmoniously with the overarching learning objectives and the essence of blended collaborative knowledge construction in vocational education. These assessment methods serve as both navigational tools for students' learning journeys and as benchmarks to gauge the attainment of desired outcomes. To accomplish this, a well-balanced blend of formative and summative assessments can be orchestrated. Formative assessments, dispersed strategically throughout the learning process, provide a continuous pulse on students' progress. These assessments, which can take the form of quizzes, discussions, or peer evaluations, offer valuable insights into individual and collective learning trajectories. Such insights not only enable instructors to tailor their instructional approaches but also encourage students to refine their collaborative knowledge construction skills incrementally. Summative assessments, deployed at the culmination of learning units, cast a discerning eye over the mastery of learning objectives. These assessments, which could comprise projects, presentations, or examinations, provide a holistic perspective on students' capacity to apply collaborative knowledge construction principles to practical scenarios. Summative assessments offer a formal snapshot of the skills, competencies, and domain-specific knowledge that students have assimilated, thereby informing both learners and educators of the successful integration of the learning model.

By thoughtfully interweaving these assessment strategies into the fabric of the learning model, educators ensure that the learning experience aligns harmoniously with the desired outcomes. Not only do these assessments act as guiding beacons for students' growth, but they also serve as a testament to the efficacy of the blended collaborative knowledge construction model in preparing vocational education students for the demands of the ever-evolving professional landscape.

4.2.2.5 Pilot and Refine: Implement the learning model in a pilot setting with a small group of students. Collect feedback from both students and instructors to identify strengths and areas for improvement.

This pilot deployment involves introducing the model to a select group of students, offering an invaluable opportunity to gauge its effectiveness, identify nuances, and refine it for optimal outcomes. During the pilot phase, students' engagement and interaction with the learning activities provide insights into the model's practicality and alignment with their needs. Their feedback, perspectives, and observations offer a wealth of qualitative data that illuminate the model's strengths and areas that warrant refinement. Additionally, instructors' experiences in guiding students through the learning process offer nuanced insights into the model's facilitation of blended collaborative knowledge construction. By collecting feedback from both students and instructors, a holistic understanding of the model's impact emerges. This multifaceted perspective serves as the foundation for refining and fine-tuning the learning model. The iterative nature of this process allows for adaptations that address any challenges and enhance the model's effectiveness. These insights not only pave the way for model enhancement but also inform decisions on modifications that enable a more seamless integration of the learning experience with vocational education dynamics.

Ultimately, the pilot and refinement phase encapsulates a cycle of continuous improvement, where insights gained from real-world applications steer the evolution of the learning model. This iterative approach ensures that the model is honed to perfection, aligning with the intricate needs of vocational education and providing an enriched platform for blended collaborative knowledge construction.

4.2.2.6 Evaluate and Validate: Conduct a comprehensive evaluation of the learning model's impact on student learning outcomes. Analyze data to validate the effectiveness of the model in enhancing collaborative knowledge construction in vocational education.

Upon completion of the pilot phase, the emphasis shifts to a rigorous evaluation and validation of the learning model's efficacy in achieving its intended goals. This pivotal step involves a thorough examination of both qualitative and quantitative data to discern the model's impact on student learning outcomes within the realm of vocational education. Quantitative analysis delves into metrics such as student performance, engagement rates, and knowledge retention to gauge the model's influence on learning achievements. Comparative analysis can be conducted between the group exposed to the learning model and a control group that follows conventional methods. This data-driven approach provides tangible evidence of the model's effectiveness in driving collaborative knowledge construction and its potential to elevate the quality of vocational education. In parallel, qualitative assessment focuses on capturing the nuanced aspects of the learning experience. In-depth interviews, surveys, and reflective reports offer insights into students' perceptions, enhanced collaborative skills, critical thinking abilities, and domain-specific knowledge acquisition. Instructors' observations also contribute to understanding how the model has transformed their teaching practices and its resonance within vocational education settings.

By triangulating the quantitative and qualitative data, a comprehensive evaluation emerges that sheds light on the model's multifaceted impact. The validation process substantiates the model's role in enriching blended collaborative knowledge construction and its alignment with the broader goals of vocational education. The resulting findings not only contribute to the body of educational research but also validate the model's significance and potential for widespread implementation.

In summary, designing a learning model that integrates learning process theories for blended collaborative knowledge construction in vocational education requires careful consideration of learning objectives, relevant theories, components, activities, assessment strategies, and technological tools. The iterative design process ensures continuous improvement and alignment with the unique context of vocational education.

Firstly, the results of Questionnaire IV were analyzed as follows:

Table 4.6 Questionnaire IV: The result of the resolution and report of 100 instructors

Domains	Confirmation (Percentage)	Disconfirmation (Percentage)	Reject (Percentage)
a. Principles			
1. Creating situations and building experience by using concept maps. **(83.0%)**	87.0	13.0	1.0
2. Stimulating learners to learn by using music and images. **(87.7%)**	97	3.0	0.0
3. Creating an atmosphere suitable for exchanging opinions by using social media for instruction. **(62.3%)**	73.0	25.0	2.0
4. Linking learners' ideas by using. (62.3%)	72.0	24.0	4.0
5. Creating experiences for learning new things before teaching new content. (58.5%)	90.0	4.0	6.0
6. Activating pre-knowledge of oneself through entry examinations, participation in games/activities, and questioning. (75.5%)	87.0	11.0	2.0
7. Exchanging ideas and correcting mistakes through final examinations; answering, and chatting on bulletin boards. (55.7%)	59.0	39.0	2.0

Table 4.6 Questionnaire IV: The result of the resolution and report of 100 instructors(Cont.)

Domains	Confirmation (Percentage)	Disconfirmation (Percentage)	Reject (Percentage)
8. Building bodies of knowledge through the steps of comprehension, memorization, analysis, and application by using supplementary activities and doing exercises after lessons. **(52.8%)**	66.0	31.0	3.0
9. Creating creativity, reflective thinking, and initiating ideas by inventing a piece of work, Summarizing designing, and inventing. **(83.1%**)	92.0	6.0	2.0
b. Teaching-learning environments			
Components of teaching-learning management are learners and instructors**. (81.1%)**	86	10	4
c. Teaching-learning/ activities strategies			
1. Stimulating attention. **(77.4%)**	80.0	18.0	2.0
2. Activating prior knowledge. **(73.6%)**	99.0	1.0	0.0
3. Informing the learners of expected outcomes.**(73.6%)**	90.0	10.0	0.0
4. Manipulating and stimulating conditions to gain attention. **(86.8%)**	93.0	7.0	0.0
5. Providing learning guidelines. **(67.0%)**	74.0	24.0	2.0
6. Searching for answers and exchanging knowledge.**(92.5%)**	94.0	6.0	0.0
7. Reflecting, memorizing, analyzing, and applying knowledge. **(77.4%)**	86.00	13.0	1.0
8. Learning through self-discovery. **(82.0%)**	86.0	12.0	2.0

Table 4.6 Questionnaire IV: The result of the resolution and report of 100 instructors (Cont.)

Domains	Confirmation (Percentage)	Disconfirmation (Percentage)	Reject (Percentage)
d. Teaching-learning models			
1. The term 'dependent learning' means that learning is designed by instructors.			
1.1 Drill-and-practice instruction. **(54.7%)**	69.0	19.0	12.0
Tests instruction means a series of test items to help students to enhance learning. **(73.6%)**	81.0	19.0	0.0
1.2 Games-based instruction is an example of dependent learning. **(40.6%)**	60.0	25.0	15.0
2. 'Independent learning' means learning is designed by students.			
2.1 'Collaborative learning' and/or 'team-based learning'. **(77.4%)**	80.0	9.0	11.0
2.2 'Project-based learning' is an example of independent learning. **(75.5%)**	78.0	12.0	10.0
2.3 'Group process learning' is an example of an independent learning. **(71.7%)**	76.0	11.0	13.0

From Table 4.6: The fourth round of resolution and report outcomes are shown in the table. The workable concepts have been found by this point. Questionnaire IV asks educators their thoughts on a number of psychology theories, including constructivism, constructionism, and Gagné's theory. All three theories are categorized by teaching-learning models as focusing on mental processes, learning by doing, and social environment. The majority of professionals firmly supported Gagné's theory regarding teaching-learning methods. The majority of professionals firmly supported Gagné's theory regarding teaching-learning methods. The study included 100 instructors of vocational education who had created electronic media in the domains of electrical engineering, electronics, civil engineering, and mechanics, such as WBI (web-based instruction), CAI (computer-assisted instruction), e-Book, and eLearning. The majority of specialists have mentioned the blended collaborative knowledge creation learning model in vocational education while discussing the evolution of electronic media. Principles, teaching-learning contexts, teaching-learning activities/strategies, and teaching-learning models were used to categorize them.

a. *Principles*. The yes response percentage was 80.3%, the no response percentage was 17.3%, and the unsure response percentage was 2.4%. Examples include setting up scenarios and developing experiences through the use of concept maps, motivating students to study through the use of music and graphics, and setting up an environment conducive to debate through the use of social media. developing experiences for learning new things before teaching new subject, leveraging hyperlinks to connect learners' thoughts, activating one's self-awareness by involvement in games and activities, admission exams, and questioning; exchanging concepts and fixing errors through final exams, answers, and discussion on message boards; By using supplemental activities and exercises after lessons, you can help students build their bodies of knowledge through the stages of comprehension, memorization, analysis, and application. You can also encourage creativity, reflective thinking, and idea generation by having them create something, summarize, or design an invention.

b. *Teaching-learning environments for learners and instructors*. The yes response percentage was 86.0%, the no response percentage was 10.0%, and the unsure response percentage was 9.5%.

c. *Teaching-learning activities/strategies*. The percentage of affirmative responses was 87.8%, the percentage of negative responses was 11.3%, and the percentage of doubtful responses was 0.9%. Examples include: getting learners' attention; getting them to use their prior knowledge; telling them what to expect; manipulating and stimulating the environment to get their attention; giving them learning guidelines; getting them to ask questions and exchange knowledge; getting them to reflect, memorize, analyze, and apply the knowledge; and learning through self-discovery.

d. *Teaching-learning models.* Dependent learning refers to instruction that is created by teachers. Examples include "drill-and-practice instruction," "tests instruction," "games-based instruction," "dependent learning," and "independent learning," which refers to learning that is created by students and may include "collaborative learning" and/or "team-based learning." 'Project-based learning' and 'group process learning' are examples of independent learning. The percentages of yes responses were 74.0%, no responses were 15.8%, and doubtful responses were 10.2%.

The design diagram of the blended collaborative knowledge construction learning theory model for vocational education is shown below:

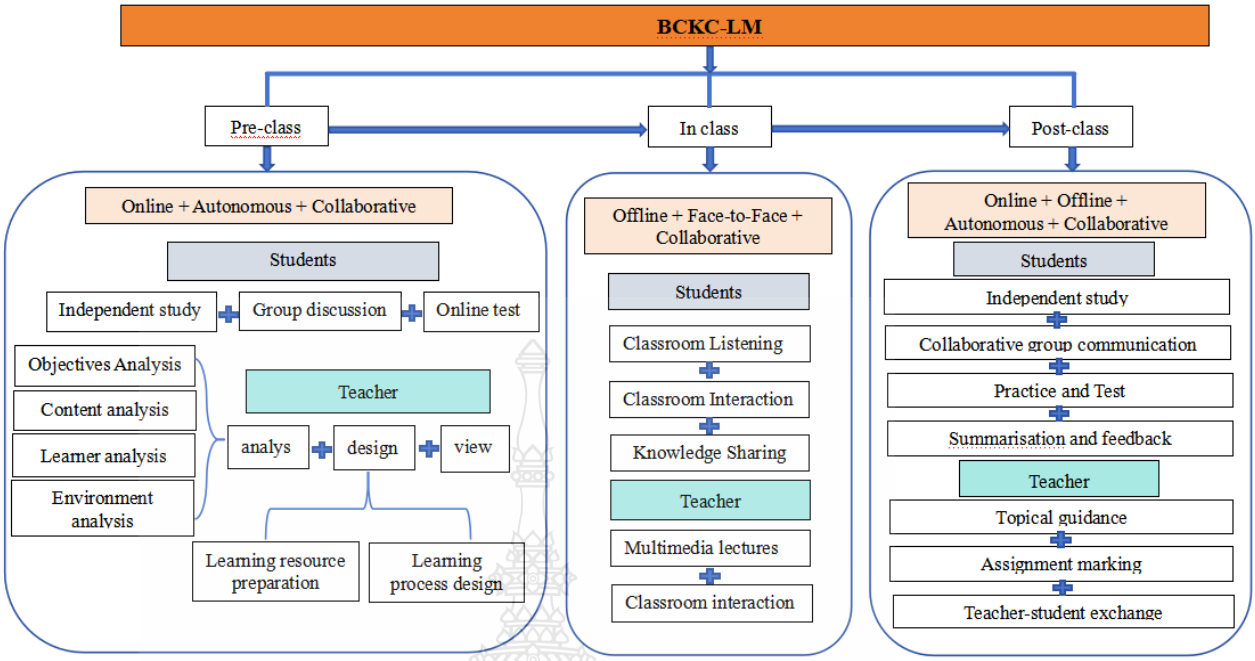

Figure 4.9 The BCKC Model of Blended Collaborative Knowledge Construction Learning in Vocational Education

The Blended Collaborative Knowledge Construction Learning Model in Vocational Education is a comprehensive approach that combines both online and offline learning environments to enhance the learning experience. This model emphasizes active collaboration among learners and the construction of knowledge through a blend of various educational strategies. By integrating online resources and interactions with face-to-face interactions, this model aims to create a dynamic and engaging learning environment that caters to the unique needs of vocational education.

In this model, learners are encouraged to participate in collaborative activities, discussions, and projects that promote knowledge construction. The integration of online platforms allows learners to access resources, engage in virtual discussions, and work on assignments remotely. Offline interactions, such as classroom sessions and group projects, foster face-to-face collaboration and hands-on application of concepts.

The model also considers the importance of individualized learning pathways, enabling learners to progress at their own pace while still benefiting from group interactions. This approach enhances not only subject-specific knowledge but also teamwork, critical thinking, and problem-solving skills that are crucial in vocational education settings.

Overall, the Blended Collaborative Knowledge Construction Learning Model in Vocational Education seeks to create a holistic learning experience that combines the advantages of both online and offline learning, fosters collaboration and empowers learners to actively construct knowledge relevant to their vocational fields.

In this learning model, the interactions between teaching principles, learning environments, and learning strategies work together to form an integrated learning model that helps students better master knowledge and improve learning outcomes and satisfaction. Students use cooperative and inquiry-based learning strategies in a diverse

learning environment and receive timely feedback and assessment, thus facilitating the construction and application of knowledge and improving learning outcomes and learning satisfaction.

4.3 Effectiveness of Blended Collaborative Knowledge Construction Learning Model

The research subjects were 60 students from Zigong Vocational Training Institute, 30 students in the experimental group, and 30 students in the control group. The experimental group adopts the blended collaborative knowledge construction learning model, and the control group adopts the traditional face-to-face learning model.

4.3.1 Pre-test data analysis

In this study, the learners' academic performance was tested by using a computer application with basic course test questions, and the experimental results were analyzed to determine whether the dimensions of academic performance in the experimental group and the control group were homogeneous. The pre-test scores of learners' academic levels in the experimental and control groups were statistically analyzed as shown in Table 4-11:

Table 4.7 Statistical Analysis of Academic Proficiency Pre-test Results of Learners in Experimental Group and Control Group

Group statistics

	Average	cases	standard deviation	standard error average
experimental group	81.02	30	9.172	1.237
control group	81.05	30	8.907	1.180

The independent sample test results of the Pre-test scores of the experimental group and the control group are shown in Table 4.8.

Table 4.8 Independent Sample Test of Learners' Pre-test Results in Experimental Group and Control Group

independent sample test

		Levine's test of variance equivalence		Mean equivalence t-test			
		F	significance	t	freedom	Significance (two-tailed)	average difference in value
Pre-test Scores	Assuming equal variance	0.147	0.702	-0.020	110	0.984	-0.034
	Not assuming equal variance			-0.020	109.532	0.984	-0.034

By analyzing the Pre-test scores, the results of SPSS data analysis show that the significance value of the F-test is 0.702, 0.702>0.05, i.e., assuming equal variance, the corresponding mean equivalence t-test results for the first row of data, from the above table, the average score of the experimental class is 81.02, and the average score of the control class is 81.05, P-value 0.984>0.05, which means that the experimental group There is no significant difference between the Pre-test scores of the experimental group and the control group and the teaching practice can be carried out. In addition, in order to ensure the effectiveness of the teaching practice and reduce the error and chance of the teaching practice, the experimental group and the control group used the same teaching materials, lecturers, and the same number of class hours.

Difference analysis of systematic and deep learning ability between the experimental group and the control group.

In practice, in order to facilitate the analysis of the experimental effect, this study analyzes the results of the Questionnaire on Systematic and Deep Learning. Blended teaching refers not only to the improvement of students' grades but also to the improvement of learners' ability and literacy in this process. This study evaluates the classroom teaching effect with systematic and deep learning as important representation points. The modified questionnaire still adopts the Likert five-point scale, with five options of "very different", "disagree", "general", "agree" and "very agree", with a score of 1-5. The questionnaire is designed from three dimensions: systematic learning motivation, learning engagement, and systematic and deep learning strategies, as shown in Table 4.9.

Table 4.9 Questionnaire design on learner satisfaction and deep learning

Dimension	Ask questions
Systematic learning motivation	I have a very pleasant and satisfying feeling in the process of classroom learning.
	I think any learning process will be more interesting as long as you put yourself into it.
	When I find learning activities interesting, I will study very hard.
	I find that sometimes studying problems can be as exciting as watching a good novel/movie.
	I think learning is a very valuable and meaningful thing.
	I think my study comes from my learning needs.
Learning input	Before class, I will do enough previews and do a lot of study preparation.
	I often ask questions in class and answer doubts by looking for evidence.
	I often take an active part in class discussions.
	I often take the initiative to express my views in class.
	I often reflect on my learning process.
	I often discuss my study questions with my teachers and classmates after class.
System and deep learning strategy	When studying, I have a clear learning goal.
	When studying, I often study with questions.
	When studying, I often try my best to demonstrate until I reach a satisfactory result.
	I often use my spare time to learn other knowledge related to classroom teaching content.
	I will use information technology to help me get information.
	I will always associate the learning content with my original knowledge.
	I will always associate my study with my life.
	I will always sort out my knowledge system.

The reliability and validity of the questionnaire are analyzed. As shown in Table 4.11, the reliability coefficient value is 0.952, and the reliability coefficient value of the research data is higher than 0.9, indicating that the data reliability quality is high.

Table 4.10 Cronbach α coefficient analysis

Number of Terms	Cronbachα Coefficient
20	0.952

Through the questionnaire survey, the learning situation of the experimental group participants before the start of the course is understood, as shown in Table 4.11:

Table 4.11 Pre-test analysis of the experimental group trainees' learning

Subject	Minimum value	Maximum	Average/ Mean value	Standard deviation
1. I feel very happy and satisfied in the process of classroom learning.	2	5	3.10	1.334
2. I think any learning process will be interesting as long as you put yourself into it.	1	5	2.70	1. 390
3. When I find learning activities interesting, I will study very hard.	2	5	3.17	.626
4. I find that sometimes when studying a problem, it can be as exciting as watching a good novel/movie.	2	5	3.07	.685
5. I think learning is a very valuable and meaningful thing.	1	5	3.03	.792
6. I think my learning comes from my learning needs.	1	5	2.90	1.059
7. Before class, I will do enough previews and do a lot of study preparation.	1	5	3.10	.852
8. I often ask questions in class and answer them by looking for evidence.	1	5	3.20	.786

9. I often take an active part in class discussions.	1	5	3.00	. 828
10. I often take the initiative to express my views in class.	1	5	3.03	.792
11. I often reflect on my learning process.	1	5	3.07	.823
12. I often discuss my study questions with my teachers and classmates after class.	1	5	2.93	.823
13. When studying, I have a clear learning goal.	1	5	3.23	.737
14. When studying, I often study with questions.	1	5	3.10	.852
15. When studying, I often try my best to demonstrate until I reach a satisfactory result.	1	5	3.03	.654
16. I often use my spare time to learn other knowledge related to classroom teaching content.	1	5	3.10	.783
17. I will use information technology to help me get information.	1	5	3.17	.902
18. I will always associate the learning content with my original knowledge.	1	5	2.87	.740
19. I will always associate my study with my life.	1	5	3.20	.717
20. I will always sort out my knowledge system.	1	5	3.07	.823

The results show that the mean value of learners' satisfaction and learning before course study in the experimental group is 3.05, the lowest is 2.7 and the highest is 3.23.

The questionnaire was used to understand the control group learners' pre-course learning satisfaction and learning situation, as shown in Table 4.12:

Table 4.12 Pre-test analysis of learning satisfaction and deep learning of control group learners

Subject	**Minimum value**	**Maximum**	**Average/ Mean Value**	**Standard Deviation**
1. I feel very happy and satisfied in the process of classroom learning.	1	5	2.87	1.085
2. I think any learning process will be interesting as long as you put yourself into it.	1	5	2.63	.654
3. I will study very hard when I find learning activities interesting.	1	5	2.93	.892
4. I find that sometimes when studying a problem, it can be as exciting as watching a good novel/movie.	1	5	2.97	.930
5. I think learning is a very valuable and meaningful thing.	1	5	2.80	.717
6. I think my learning comes from my learning needs.	1	5	2.80	.717
7. Before class, I will do enough previews and do a lot of study preparation.	1	5	2.87	.947
8. I often ask questions in class and answer doubts by looking for evidence.	1	5	2.97	.723
9. I often take an active part in class discussions.	1	5	2.80	.717
10. I often take the initiative to express my views in class.	1	5	2.83	.695

11. I often reflect on my learning process.	1	5	2.87	.740
12. I often discuss my study questions with my teachers and classmates after class.	1	5	2.90	. 714
13. When studying, I have a clear learning goal.	1	5	3.10	.783
14. When studying, I often study with questions.	1	5	3.17	.764
15. When studying, I often try my best to demonstrate until I reach a satisfactory result.	1	5	2.90	. 852
16. I often use my spare time to learn other knowledge related to classroom teaching content.	1	5	2.87	. 671
17. I will use information technology to help me get information.	1	5	2.93	.685
18. I will always associate the learning content with my original knowledge.	1	5	2.77	.737
19. I will always associate my study with my life.	1	5	2.90	.921
20. I will always organize my knowledge system.	1	5	3.10	.714

The results show that the average satisfaction learning status of the learners in the control group is 2.90, the lowest is 2.63, and the highest is 3.17.

Through the questionnaire survey of satisfaction and deep learning ability of the control group and experimental group, the results showed that the systematic deep learning ability of the experimental group was slightly higher than that of the control group, with an average difference of 0.15, but the difference was not significant.

4.3.2 Analysis of post-test data

In this study, the academic performance of learners in teaching activities based on the blended collaborative knowledge construction learning model in

vocational education was analyzed in comparison with the academic performance of learners in traditional teaching activities to illustrate the impact of the blended collaborative knowledge construction learning model on academic performance.

The final examination paper grades of the students in the experimental and control groups were entered into SPSS for descriptive statistical analysis, and the mean score of the experimental group was 84.87, with a maximum of 98 and a minimum of 45, while the mean score of the control group was 74.16, with a maximum of 94 and a minimum of 51; the specifics of the grades of the control and experimental groups are shown in the table below.

Table 4.13 Statistical Analysis of Final Examination Scores of Experimental and Control Groups

	groups	Number of cases	average value	standard deviation	Mean standard error
mark	experimental group	30	84.87	12.13513	1.63630
	control group	30	74.16	8.14553	1.07890

Table 4.14 T-test for student achievement in control and experimental groups

		Levine's test of variance equivalence		Mean equivalence t-test						
		F	significance	t	freedom	Significance (two-tailed)	mean difference	standard error margin	Difference 95% confidence interval	
									lower limit	limit
mark	Assuming equal variance	3.210	0.076	-5.504	110	0.000	-10.71483	1.9466	-14.573	-6.857
	Not assuming equal variance			-5.467	94.023	0.000	1.94664	1.9599	-14.606	-6.823

The independent samples T-test was conducted in SPSS on the final examination results of the experimental and control groups, and the results of the analysis are shown in the table above, the significance result of the F-test is 0.076, 0.076>0.05, that is, assuming that the variances are equal, the results of the independent samples T-test of the variances are correct, and the significance P-value of the T-test is 0<0.05, which means that after the implementation of the experiment of the mixed collaborative knowledge construction learning model, the There is a significant difference between the academic performance of the students in the experimental group and the control group.

The experimental data confirms that the blended collaborative knowledge construction learning model improves academic performance better than the traditional learning approach.

4.3.3 Analysis of the impact of blended collaborative knowledge construction learning model on learners' systematic and deep learning in vocational education.

1. post-test analysis of learners' systematic learning and deep learning in the experimental group.

1) Post-test analysis of learners' systematic learning and deep learning.

Through the questionnaire survey, learners' systematic learning and deep learning in the experimental group after the course, as shown in Table 4.15:

Table 4.15 Table of systematic and deep learning of participants in the experimental group at the end of the course

Subject	**Minimum value**	**Maximum**	**Average value**	**Standard deviation**
1. I feel very happy and satisfied in	3	5	4.13	.776

the process of classroom learning.				
2. I think any learning process will be interesting as long as you put yourself into it.	2	5	4.37	.964
3. I will study very hard when I find learning activities interesting.	3	5	4.43	.728
4. I find that sometimes when studying a problem, it can be as exciting as watching a good novel/movie.	2	5	4.17	.986
5. I think learning is a very valuable and meaningful thing.	2	5	4.13	1.008
6. I think my learning comes from my learning needs.	2	5	4.10	.923
7. I will do enough preparation before class and do a lot of study preparation.	2	5	4.17	.950
8. I often ask questions in class and answer them by looking for evidence.	2	5	4.33	.844
9. I often take an active part in class discussions.	2	5	4.37	.809
10. I often take the initiative to express my views in class.	2	5	4.23	.858
11. I often reflect on my learning process.	2	5	4.27	.828
12. I often discuss my study questions with my teachers and classmates after class.	2	5	4.23	.774
13. When studying, I have a clear	2	5	4.20	.847

learning goal.				
14. When studying, I often study with questions.	3	5	4.27	.691
15. When studying, I often try my best to demonstrate until I reach a satisfactory result.	3	5	4.37	.718
16. I often use my spare time to learn other knowledge related to classroom teaching content.	2	5	4.30	.702
17. I will use information technology to help me get information.	3	5	4.27	.640
18. I will always associate the learning content with my original knowledge.	2	5	4.37	.718
19. I will always associate my study with my life.	2	5	4.33	.802
20. I will always sort out my knowledge system.	3	5	4.37	.615

The results show that the post-test learning situation of systematic and deep learning in the experimental group is higher, with an average of 4.27, the lowest average of 4.10, and the highest of 4.43, which comprehensively shows that the systematic and deep learning situation of learners is better.

2) Comparative analysis of systematic and deep learning in experimental groups before and after the test.

Compare the pre-test and post-test of systematic and deep learning in the experimental group, as shown in Figure 4.10.

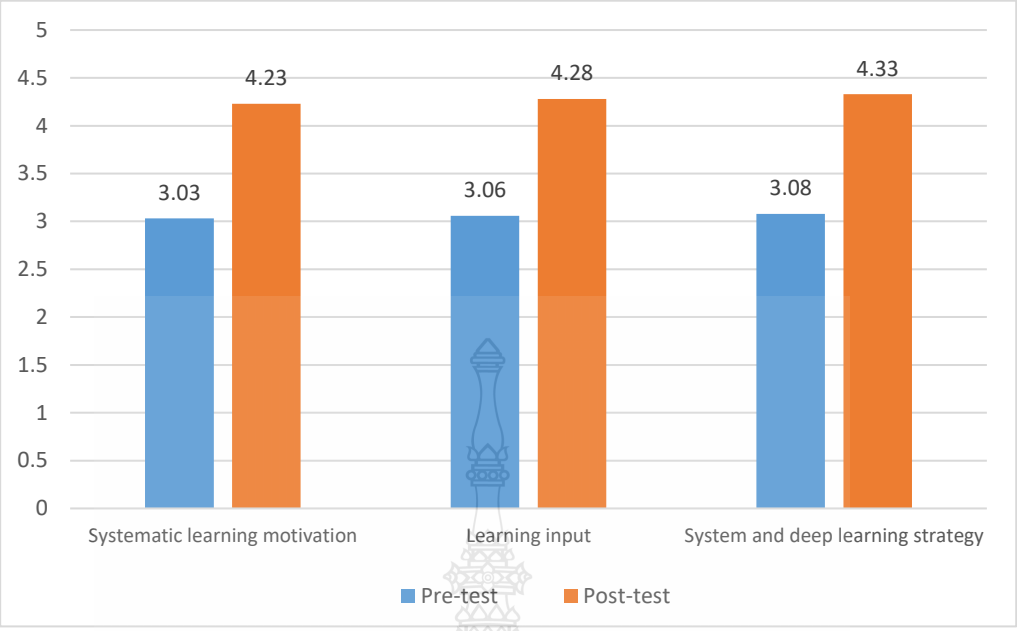

Figure 4.10 Comparison of Deep Learning of Learners in Experimental Group before and after the test.

The results show that in the dimensions of systematic and deep learning motivation, the average of the pre-test and post-test of the experimental group are 3.03 and 4.23 respectively. In the dimension of learning engagement, the average of the pre-test and post-test in the experimental group is 3.06 and 4.28, respectively. In the dimension of systematic and deep learning strategies, the average of pre-test and post-test of the experimental group is 3.08 and 4.33, indicating that the systematic and deep learning ability of the experimental group has been improved through learning.

2. Systematic and deep learning of control group learners before and after testing analysis

1) Post-test analysis of systematic and deep learning in the control group.

Investigate the learners in the control group through questionnaires to understand the systematic and deep learning situation after the course study, as shown in Table 4.17:

Table 4.16 Post-test Analysis of Systematic and Deep Learning of Learners in Control Group

Name	Minimum value	Maximum	Average value	Standard deviation
1. I feel very happy and satisfied in the process of classroom learning.	2	5	3.10	.803
2. I think any learning process will be interesting as long as you put yourself into it.	2	4	2.93	.691
3. I will study very hard when I find learning activities interesting.	1	5	2.77	1.104
4. I find that sometimes when studying a problem, it can be as exciting as watching a good novel/movie.	1	5	2.53	1.106
5. I think learning is a very valuable and meaningful thing.	1	4	2.50	1.075
6. I think my learning comes from my learning needs.	1	4	2.77	.774
7. I will do enough preparation before class and do a lot of study preparation.	2	5	2.97	.765
8. I often ask questions in class and answer them by looking for evidence.	1	4	2.83	.913
9. I often take an active part in class discussions.	1	4	2.97	.890
10. I often take the initiative to express my views in class.	1	4	2.80	.887
11. I often reflect on my learning process.	1	4	2.73	.828

12. I often discuss my study questions with my teachers and classmates after class.	1	4	2.97	.809
13. When studying, I have a clear learning goal.	1	4	3.00	.830
14. When studying, I often study with questions.	2	4	3.10	.712
15. When studying, I often try my best to demonstrate until I reach a satisfactory result.	1	4	2.90	.803
16. I often use my spare time to learn other knowledge related to classroom teaching content.	1	4	2.87	.900
17. I will use information technology to help me get information.	1	4	3.00	.743
18. I will always associate the learning content with my original knowledge.	1	4	2.83	.834
19. I will always associate my study with my life.	2	4	2.93	.740
20. I will always organize my knowledge system.	2	5	2.97	.718

The results show that the average post-test learning situation of systematic and deep learning in the control group is 2.87, the lowest average is 2.50, and the highest is 3.10, which shows that the systematic and deep learning situation of learners is not good.

2) Comparative analysis of systematic and deep learning of the control group.

The comparison between the pre-test and post-test of systematic and deep learning of the control group learners is shown in Figure 4.11:

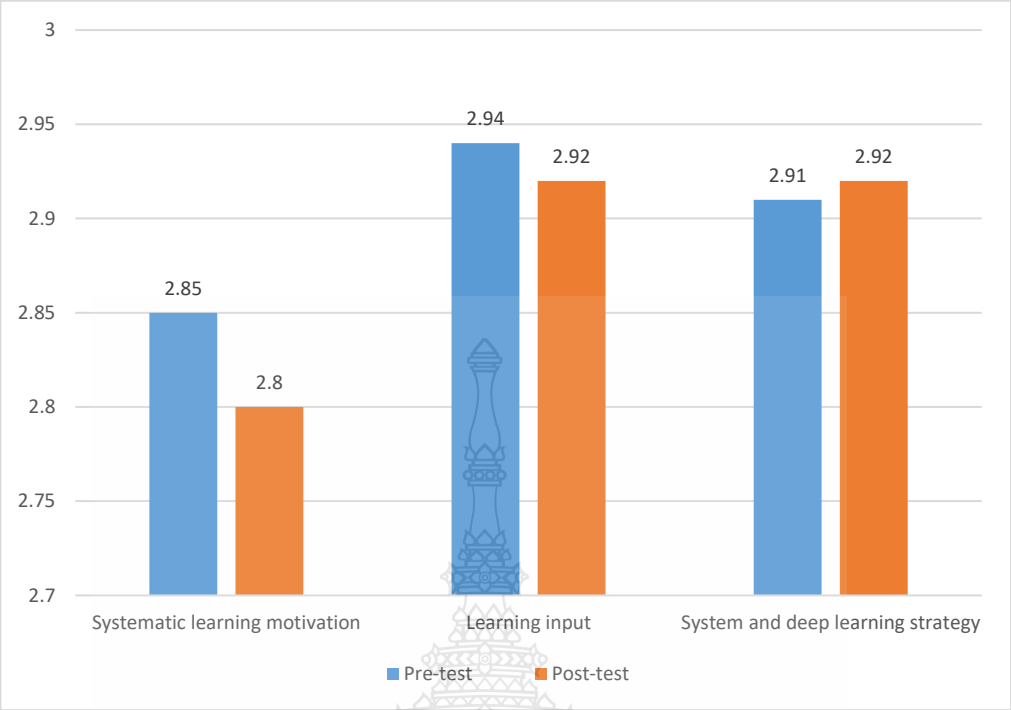

Figure 4.11 Comparison of Systemic and Deep Learning in the Control Group before and after the test.

The results show that in the dimensions of systematic and deep learning motivation, the average pre-test and post-test of the control group learners are 2.85 and 2.8 respectively. In the dimension of learning engagement, the average of the pre-test and post-test of the control group learners are 2.94 and 2.91, respectively. In the dimension of systematic and deep learning strategies, the average of pre-test and post-test of the control group is 2.91 and 2.92, which shows that the systematic and deep learning ability of the control group has not been improved through learning.

3. Comparative analysis of deep learning between the experimental group and control group

Analyze the three dimensions of the deep learning of the learners in the experimental group and the control group, as shown in Figure 4.12:

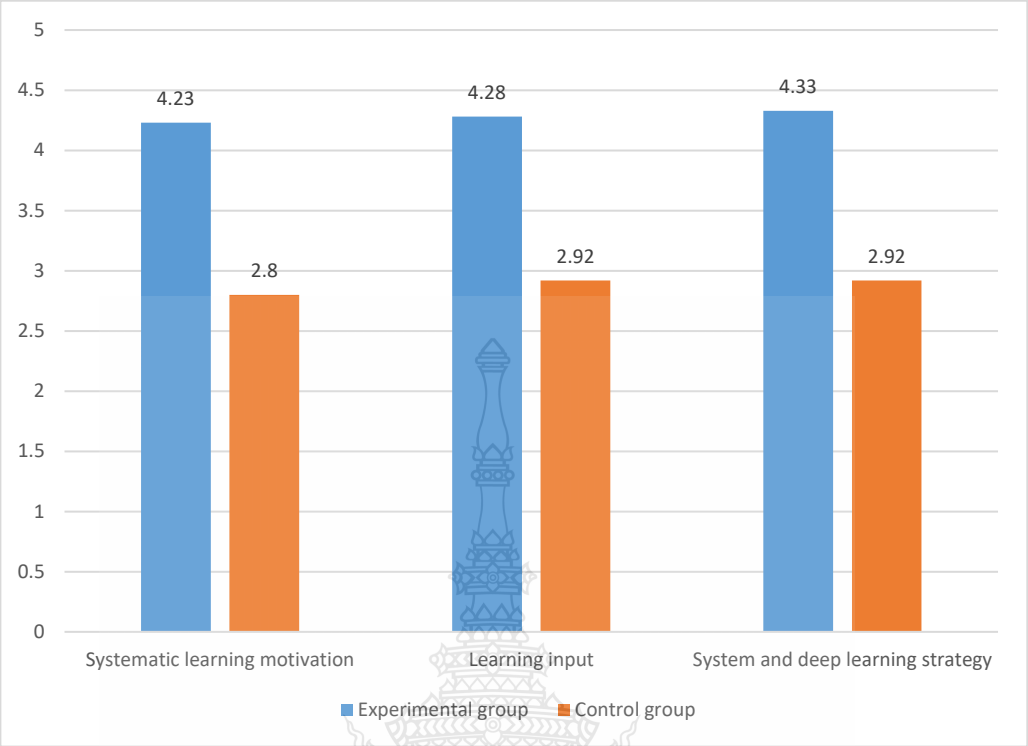

Figure 4.12 Systematic and Deep Learning of Learners in Experimental Group and Control Group

The results show that in the dimensions of systematic and deep learning motivation, the average value of learners in the experimental group is 4.23, while that in the control group is 2.8. In the dimension of learning engagement, the average value of learners in the experimental group is 4.28, and that of the control group is 2.92. In the dimensions of systematic and deep learning strategies, the average value of the learners in the experimental group is 4.33, while that in the control group is 2.92. There are some differences between the experimental group and the control group in the systematic and deep learning, and the systematic and deep learning of the experimental group is better than that of the control group, which shows that teaching activities under Blended Collaborative Knowledge Construction Learning Model vocational education are more conducive to cultivating learners' deep learning ability.

The experimental results show that the above hypotheses are fully supported by the experimental results. First, compared with the traditional teaching mode, the blended collaborative knowledge construction learning mode is more conducive to improving learners' academic performance, and there is a significant difference between learners' academic performance and that of the traditional teaching mode; second, compared with the traditional teaching mode, the blended collaborative knowledge construction learning mode is more conducive to promoting learners' systematic and deep learning, and the learners' motivation for systematic learning, learning inputs, systematic learning and deep learning strategies are all better than those of the traditional teaching mode. Learners' systematic learning motivation, learning input, systematic learning, and deep learning strategies are better than those of the traditional teaching mode.

CHAPTER 5
DISCUSSION AND RECOMMENDATION

This chapter provides the summary, discussion, conclusion, limitations, and contributions of the study, synthesizing learning process theories and creating a learning model for blended collaborative knowledge construction in vocational education for Sichuan Province, China.

This research has a summary as follows:

5.1 Summary of Results
5.2 Discussion of Results
5.3 Conclusion
5.4 Limitations
5.5 Contributions

5.1 Summary of Results

The summary of results from this research is presented in two phases:

5.1.1 To synthesize learning process theories related to a blended collaborative knowledge construction learning model for vocational education in Sichuan Province, China.

The two theories of learning by doing, social context, psychological theories of principles, teaching-learning activities and strategies, teaching-learning environments, stages of instructional sequence, and teaching-learning models are the main focuses of orientation learning theories, which are illustrated in Table 5.1-5.5.

Table 5.1 Principles of Constructivism and Constructionism in a Social Context

Main term	Principles
Constructivism is a learning-by-doing approach.	Engaging in working and thinking activities, societal actions, cognition, active methods, and knowledge sharing.
Constructionism in a social context.	Develop interaction and social skills through knowledge-building, situational constructionism, situated learning, and experiential learning.

Table 5.2 Constructivism and constructionism teaching strategies for social context

Constructivism is a learning-by-doing approach	**Constructionism in a social context**
Self-understanding and work-based learning activities enhance course understanding.	Social strategies construct knowledge through context.
Fostering independent thinking and learning.	Exploring construction.
Sharing knowledge and skills through diverse learning environments.	Sharing construction.
Constructing knowledge.	Creating wit and knowledge by themselves.
Access to Activities and Games for Activity and Performance Monitoring.	Working socially.
Presenting an organization of knowledge.	Transferring organization of knowledge.

Table 5.3 Teaching-learning environments according to constructivism (learning by doing approach), and constructionism (social context)

Teaching - Learning Environments	**Constructivism (learning-by-doing an approach)**	**Constructionism (social context)**
Using educational media.		
Concept map	x	x
Spider diagram	x	x
Fishbone	x	x
Structured	x	x
T-chart	x	x
Using action, activities, and environments.		
Interactions within a learning-by-doing process.	/	x
Sharing their knowledge and skills through various types of social activities.	/	x
Activities/opportunities to develop meta-cognitive knowledge about people.	/	x
Tasks	/	x
Strategies to evaluate their learning by their own part of the total experience.	/	x
Using interaction with social constructionists.		
Self-learning (simulation and games)	x	/
Experiential learning.	x	/

Perceptions of experience by their understanding.	x	/
Construction by themselves, or thinking of it as learning-by-making.	x	/
Actions for social learning.	x	/
Interaction and cognitive process.	x	/

Table 5.4 The teaching-learning model according to constructivism (learning by doing), and constructionism (social context)

Constructivism (learning by doing an approach)	**Constructionism (social context)**
- Learning by doing - Co-operative learning - Project-based learning - Problem-based learning - Group Investigation - Inquiry method - New knowledge - Planning to learn by themselves - Presentation	- Self-learning (simulation and games) - Situation learning - Brainstorms for projects - Learning assessment - Modifying actions

5.1.2 To identify and develop a blended collaborative knowledge construction learning model for vocational education in Sichuan, China

This results from the experts' opinions in identifying and developing a blended collaborative knowledge construction learning model using learning process theories for vocational education in Sichuan, China. It was created from psychology theories, namely constructivism (learning by doing) and constructionism (social context), as shown in Figure 5.1.

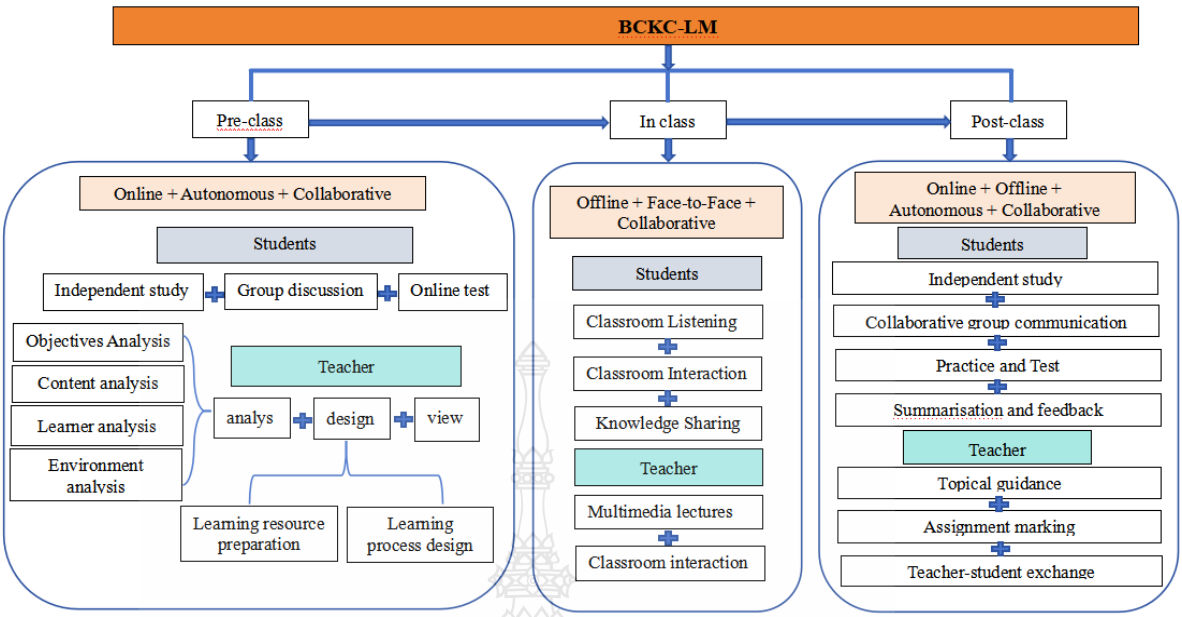

Figure 5.1 The Blended Collaborative Knowledge Construction （BCKC）Learning Model for Vocational Education in Sichuan Province, China

Table 5.5 BCKC Learning Model: A Blended Collaborative Knowledge Construction Learning Model for Vocational Education in Sichuan Province, China

BCKC Leaning Model	**The stages of the learning process**
Signals learning	Instructors guide conditional learning by providing learners with information, objectives, outcomes, benefits, and teaching criteria, activating receptors, setting expectations, and enhancing short-term memory retrieval and activation.
Chaining	Instructors guide learners through a step-by-step learning process, enhance encoding, create verification, and provide retrieval and reinforcement for learning. They also evaluate and generalize learned skills for new situations.
Verbal association	Learners rethink, find questions, and perform self-regulation learning in instruction models.
Discrimination	Learners learn through testing, feedback, sharing activities, understanding, regulating, and presenting knowledge.
Concept learning	Instructors create tasks and conditional learning for learners while learners and instructors share thoughts and knowledge.
Rule learning	Learners achieve learning objectives and meet conditional learning, while instructors construct self-constructionist structures.

Table 5.5 BCKC Learning Model: A Blended Collaborative Knowledge Construction Learning Model for Vocational Education in Sichuan Province, China(Cont.)

BCKC Leaning Model	**The stages of the learning process**
Problem-solving	Instructors offer instructions, tutorials, simulations, games, drills,

	practice, and tests for learners, enabling them to construct knowledge through communities and solve problems.
Creative thinking	Encourage learners to understand reflective thinking, discuss knowledge organization, and share information for effective knowledge management.
Self-learning	Learners can plan and solve problems independently using simulation and gaming media while instructors and learners collaborate on tasks and experiences.

Table 5.6 SRCK: Self-Regulated Content Knowledge

SRCK: Self-Regulated Content Knowledge	**Teaching-learning environments**
Content knowledge aids in mental processes (Stebner et al., 2022).	Learners utilize educational media for cognitive mental processes.
Learn content knowledge through doing.	Learners utilize action activity environments, sharing knowledge and skills and evaluating their learning through social activities to develop meta-cognitive knowledge about individuals, tasks, and strategies.
Content knowledge for constructing social context.	Learners engage with social constructionists, constructing social context through experiential learning, understanding, and cognitive processes.

Table 5.7 BCLCK: Blended Collaborative Learning Content Knowledge

Blended Collaborative Learning Content Knowledge**(BCLCK)**	**Instructors**	**Learners**
Creating content knowledge for stimuli to activate receptors, level of expectation for learning, semantic encoding for storage of long-term memory, verification.	√	X
Reinforcement and assessment of correct performance, build content knowledge for retrieval and activation of short- term memory, select content knowledge for the perception of content.	√	X
Improving content knowledge for how a learner responds to questions to enhance encoding.	√	X
Creating Content Knowledge for Learning Strategies Blending Collaborative Knowledge to Construct Knowledge of Learning Content.	√	X
Create retrieval and reinforcement of content as the final evaluation of learning, and retrieval and generalization of learned skills for learners to build new situations.	√	X

Rethinking to activate pre-knowledge of content knowledge.	X	√
Finding questions from content knowledge.	X	√
Perform self-regulated learning by doing their tasks of content knowledge.	X	√
Sharing content knowledge and activities together.	X	√
Sharing understanding of knowledge and content knowledge with instructors.	X	√
Sharing regulating activities to transfer content knowledge.	X	√
Presenting of content knowledge activities.	X	√
Sharing thoughts and building their own self-knowledge.	√	
Building structures to construct self-social contexts.	√	
Constructing knowledge-building communities.	√	
Discussion and constructing knowledge organization.	√	
Sharing and constructing information to manage knowledge.	√	
Constructing and collaborating on the social context of their tasks.	√	
Combination experiences to develop themselves.	√	

Table 5.8 Vocational Education Content Knowledge (VECK)

Vocational Education Content Knowledge (VECK)	
Teaching for vocational education content knowledge.	- Creating conditions for internal mental learning processes such as insight information. - Creating processing memory. - Perception knowledge and information. - Providing situated cognition (content, activities).
	- Performing access processes (drill and practice). - Supporting the construction of knowledge.
Activities learning for vocational education content knowledge.	- Activities learning through their own self-understanding of the course with learning by doing work. - Creating thinking together with the ability to learn on their own. - Sharing their knowledge and skills through various types of method learning environment. - Constructing knowledge. - Activity, access processes performance (activities and games).
Learning for vocational education content Knowledge.	- Using education media, action activities environments, and interaction with social constructionists in constructing content knowledge for signals learning. - Information for chaining that learners can learn on their own (objective of learning, activities, events of learning, step-by-step process learning, instructional media). - Create activities verbal association (using process learning, and instructional models).

Table 5.8 Vocational Education Content Knowledge (VECK) (Cont.)

Vocational Education Content Knowledge (VECK)	
	- Setting events for learning regarding discrimination learning (testing, feedback learning). - Construct content knowledge for learners to create concept learning (create tasks, conditional learning, method learning, stages of the teaching of the learning process, Select media, environment management). - Construct content knowledge in rule learning so learners can be self-regulated (how to able to achieve objectives of learning and conditional learning). - Construct social contexts for the learners to solve problems by themselves. (instruction models such as programmed, tutorials, simulation games drill and practices, test) - Construct social context for the learner to be able to do creative thinking, recognition, understanding of sustainability according to reflective thinking, and thinking initiatives. - Construct social context so learners can Do self-learning, (learners can learn by doing and planning, setting assumptions, doing investigations, and solving problems independently).
Self-regulated model for vocational education content knowledge.	- Brainstorms for projects - Planning their own learning - Learning by doing - Presentations - Learning assessments - Modifying actions

Table 5.8 Vocational Education Content Knowledge (VECK) (Cont.)

Vocational Education Content Knowledge (VECK)	
Social media model for vocational education content knowledge.	- Construction of knowledge by social strategies through social context. - Discussing constructions - Sharing constructions - Creating wit and knowledge by themselves. - Working socially - Promote reflection and articulation for learning and teaching.

A framework and design methodology for a blended collaborative knowledge creation learning model for vocational education is presented in this article by researchers. The BCKC model must be implemented in a number of processes that take into account various informational factors, conceptual growth, psychological theories, and an overall evaluation of the system environment's level of quality. This study's main objective was to enhance the design and usability of a blended collaborative knowledge construction learning model for vocational education. The study also confirms that elements of the online and offline learning environments, such as the application of domain knowledge, conceptual theories, psychological theories, and the overall quality assessment of the design process, should be taken into consideration for the success of the design framework of the Blended Collaborative Knowledge Construction Learning Model for Vocational Education (BCKC model).

5.2 Discussion of Results

The Blended Collaborative Knowledge Construction Learning Model for Vocational Education (BCKC) model can be used to address issues like the absence of environment management in electronic media and in technology-enhanced, learner-centered environments where there has been no integration of psychology theories or students' understanding of how the abstract becomes concrete. Due to students' ability to detect graphically portrayed changes in concrete experience, it can also help pupils learn and understand abstract concepts. Additionally, thanks to the development of both online and offline collaborative learning settings, students may interact and collaborate with teachers and other students more effectively.

The study discovered the expert opinions on the design and evaluation of learning models in terms of learners' activities and critical thinking style; application of prior knowledge; novel situations; problem-solving; researching decisions; and making critical evaluations; clear thinking; presenting in class; and instructors' promotion of class participants/controlling activities; effortful endeavor; task design; and instructors' organization of his or her thought; making notes and an outline of ideas and social context (building knowledge and situation models in the cloud: project brainstorming, planning one's own learning, learning by doing, new information, presentations, learning assessments, and changing actions); developing learners' interaction styles: the interaction of people with their environment, participation in communities of practice, and resource utilization; and encouraging students to work together and learn together.

By establishing new knowledge and conceptual understanding, fostering creativity, and helping learners develop problem-solving techniques, instructors create a situational learning environment.“To develop people to be able to create knowledge and learn by themselves, learning innovation is important. This will enable learners to learn and develop students' potential in a sustainable manner.” (Kwangmuang et al., 2021)

5.3 Conclusion

As a productive, successful, adaptable, and simple-to-use methodology, the Blended Collaborative Knowledge Construction (BCKC) Learning methodology for Vocational Education was created. It does not, however, only apply to vocational education. The BCKC model is viewed by the majority of experts as being effective, flexible, and simple to use in the creation of electronic media, including scenario-based learning, group investigations, and inquiry methodologies in the field of vocational education (e.g., electrical, electronic, civil, and mechanical).

5.4 Limitations

One limitation of the Delphi technique is that the results are determined by the number of experts who respond to the study. In this case, 17 experts participated. The Delphi technique was time-consuming in getting the opinion of experts for the first round when consent forms were needed and a large amount of time was necessary for improving questions. The questions for the first round are usually open-ended, which requires more work for the experts. In the first round, the experts gave their opinions via their vast experience and knowledge of the framework for the interview scheme or the semi-structured interview form. Then the results of the interviewing or the first round of brainstorming were collected. The results of the first round according to the second round and the third round are not particularly time-consuming for the experts. Another drawback of the study is that it only included Chinese subject matter experts in instructional design for vocational education, and the evaluator's skill level and bias hindered their ability to comprehend the facts they received.

5.5 Contributions

The Delphi technology is significant because it offers a fresh framework for teachers to create blended, collaborative lessons for students in vocational education. It is a circular instructional design methodology that offers review at every stage of the process to enable both efficient and prompt production of inherited projects in addition to effective new designs. Another novel approach to teaching and learning at the vocational level is provided by the Blended Collaborative Knowledge Construction (BCKC) learning model for vocational education, which will have an impact on choices about the teaching methods to be employed. By employing the Delphi procedure, the researchers created the BCKC learning model, which incorporates constructivism, behaviorism, and constructionism as well as an emphasis on mental processes, the learning-by-doing method, and social context in order to discover a model. The Blended Collaborative Knowledge Construction (BCKC) Learning Model for Vocational Education will benefit from an analysis of the model by the opinions of specialists in the field of instructional design after the Delphi technique has been finalized. The approach

is expected to contribute to the creation of curricula that are more effectively developed and created for today's learning environments, as well as more effective and efficient learning environments. Anyone using the enhanced Blended Collaborative Knowledge Construction (BCKC) Learning model for instructional design will gain from adopting it for vocational education.

Thus, the significance of the study may specifically be summarized as follows:

1. Instructors can apply the results of this study to develop a teaching style for the management of learners' activity so they may learn by themselves.

2. Learners can apply the results of this study to a learning style that allows them to make sense of the new information that they are receiving by themselves.

3. Both, instructors and learners can apply the results of this study to the learning style of active participants who construct their own self-understandings of the world around them by using past experience and knowledge.

4. Also, this could improve the online and offline learning programs to help learners achieve their learning objectives effectively and efficiently, as well as help learners understand in a faster and more stable way.

5. The BCKC model shown here has implications for future study. A framework and design approach for a blended collaborative knowledge construction learning model for vocational education is provided by the researcher. The BCKC model had to be put into practice in a number of ways, including by taking into account various informational facets, developing conceptual frameworks, applying psychological theories, and assessing the entire system environment's quality. This project specifically intends to enhance the usability and design process of a blended collaborative knowledge construction learning model for vocational education. The study also confirms that a variety of online and offline learning environment factors, such as the application of domain knowledge, conceptual theory, psychology theories, and evaluation of the overall quality of the design process, should be taken into account for the Blended Collaborative Knowledge Construction (BCKC) learning model in vocational education to be successful.

In addition, the researchers suggest that the model can be used to support instructional design for blended collaborative knowledge construction learning models in other content areas or at other educational levels.

Bibliography

Appendix A Invitation letter of Experts

1. Prof. Xie Hua. Dean, College of Education and Psychological Science, Sichuan University of Science and Engineering, China.

2. Associate Professor. Li Bo. Associate Dean, College of Education and Psychological Science, Sichuan University of Science and Engineering, China.

3. Associate Professor.Xiong Lijuan.College of Education and Psychological Science, Sichuan University of Science and Engineering, China.

4. Professor.Shen Minghong.College of Education and Psychological Science, Sichuan University of Science and Engineering, China.

5. Professor.Sun Shan.Director of Academic Affairs, Sichuan University of Science and Engineering, China.

6. Associate Professor.Liang Xingjian.College of Computer Science and Engineering, Sichuan University of Science and Engineering，China.

7. Senior Lecturer.Tian Xiaogang.Zigong Vocational and Technical School.

8. Associate Professor.He Xiaoli.College of Computer Science and Engineering, Sichuan University of Science and Engineering，China.

9. Professor.Peng Yan.Director, Engineering Practice Centre, Sichuan University of Science and Engineering, China.

10. Professor.Jiang Zhijie.Dean, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.

11. Professor.Li Tianzeng.Associate Dean, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.

12. Dr.Su Yuebin. Head, Department of Information and Computing Sciences,College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
13. Associate Professor.Bai Hongbin. Head of Department of Statistics,College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
14. Professor.Liu Xiaolan. Head, Department of Mathematics and Applied Mathematics, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
15. Associate Professor.Lin Fuming.Deputy Head of the Department of Statistics, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
16. Associate Professor.Li Yundong.Deputy Head, Department of Information and Computing Sciences, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
17. Dr.Xiang Yi.Deputy Head, Department of Mathematics and Applied Mathematics, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.

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15 July, 2023

Dear Prof. Xie Hua. Dean, College of Education and Psychological Science, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

If you have any questions or need further information, please feel free to contact Mr. Mo Biquan, on the e-mail: biquan_m@mail.rmutt.ac.th

Yours sincerely,

(Assistant Professor Arnon Niyomphol)
Dean of Faculty of Technical Education

MHESI 0909.27/2023

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15 July, 2023

Dear Associate Professor. Li Bo. Associate Dean, College of Education and Psychological Science, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

If you have any questions or need further information, please feel free to contact Mr. Mo Biquan, on the e-mail: biquan_m@mail.rmutt.ac.th

Yours sincerely,

(Assistant Professor Arnon Niyomphol)
Dean of Faculty of Technical Education

MHESI 0909.28/2023

Office of the Dean, Faculty of Technical Education
Rajamangala University of Technology Thanyaburi
Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Associate Professor.Xiong Lijuan.College of Education and Psychological Science, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

(Assistant Professor Arnon Niyomphol)
Dean of Faculty of Technical Education

MHESI 0909.29/2023

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Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Professor.Shen Minghong.College of Education and Psychological Science, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

(Assistant Professor Arnon Niyomphol)
Dean of Faculty of Technical Education

MHESI 0909.30/2023

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Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Professor.Sun Shan.Director of Academic Affairs, Sichuan University of Science and Engineering, China.

Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

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Dean of Faculty of Technical Education

MHESI 0909.31/2023

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Klong Luang, Pathum Thani 12110 Thailand
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15 July, 2023

Dear Associate Professor.Liang Xingjian.College of Computer Science and Engineering,
Sichuan University of Science and Engineering, China.

Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thospom Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

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Dean of Faculty of Technical Education

MHESI 0909.32/2023

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Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Senior Lecturer.Tian Xiaogang.Zigong Vocational and Technical School.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

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Dean of Faculty of Technical Education

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Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Associate Professor.He Xiaoli.College of Computer Science and Engineering, Sichuan University of Science and Engineering, China.

Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Dean of Faculty of Technical Education

MHESI 0909.34/2023

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Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Professor.Peng Yan.Director, Engineering Practice Centre, Sichuan University of Science and Engineering, China.

Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

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Dean of Faculty of Technical Education

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Rajamangala University of Technology Thanyaburi
Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Professor.Jiang Zhijie.Dean, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thospom Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

(Assistant Professor Arnon Niyomphol)
Dean of Faculty of Technical Education

MHESI 0909.36/2023

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Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Professor.Li Tianzeng.Associate Dean, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

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Dean of Faculty of Technical Education

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Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Dr.Su Yuebin. Head, Department of Information and Computing Sciences,College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

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Dean of Faculty of Technical Education

MHESI 0909.38/2023

Office of the Dean, Faculty of Technical Education
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Klong Luang, Pathum Thani 12110 Thailand
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15 July, 2023

Dear Associate Professor.Bai Hongbin. Head of Department of Statistics,College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

I am writing to request your assistance as an honorary external research reviewer in evaluating the research instruments of Mr.Mo Biquan, Doctor of Science Program in Technical Education (Vocational Education) Rajamangala University of Technology Thanyaburi, who has been working on the dissertation titled "Development of a Learning Model for Blended Collaborative Knowledge Construction in Vocational Education". under the supervision of Assistant Professor Dr. Thosporn Sangsawang. In this regard, I would like to request your valuable time to evaluate the research instruments as I strongly believe that your expertise will be of great value in improving the research instruments.

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Yours sincerely,

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15 July, 2023

Dear Professor.Liu Xiaolan. Head, Department of Mathematics and Applied Mathematics, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

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Yours sincerely,

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MHESI 0909.40/2023

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Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Associate Professor.Lin Fuming.Deputy Head of the Department of Statistics, College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

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Dean of Faculty of Technical Education

MHESI 0909.41/2023

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Klong Luang, Pathum Thani 12110 Thailand
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15 July, 2023

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Dean of Faculty of Technical Education

MHESI 0909.42/2023

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Klong Luang, Pathum Thani 12110 Thailand
Tel:+66-2-549-4710 Fax:+66-2-577-5049

15 July, 2023

Dear Dr.Xiang Yi.Deputy Head, Department of Mathematics and Applied Mathematics,
College of Mathematics and Statistics, Sichuan University of Science and Engineering, China.
Subject: Respectfully requesting a letter of invitation of experts for Ph.D. Dissertation

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Dean of Faculty of Technical Education

Appendix B Instruments:Brainstorming

Instruments: I First Round: Brainstorming
Semi-Structured Interviews

Semi-Structured Interviews Question

Semi-Structured interviews question is associate with conceptual framework of constructvism and constructionism. There are four parts as in: (1) principles, (2) teaching-learning environments, (3) stages of teaching-learning activities, and (4) teaching-learning model. In this regard, experts will comment on the frame or by responding to ideas. “Please writes your specify any suggestion”

1. Constructivism	
1.1	What do you think about the **‘principles’of constructivism** which covers the contents in instruction? For example:
Please selects your specify any suggestion in blank	
……..	1) Test learners’ prior knowledge before giving new knowledge.
……..	2) Review learners’ prior knowledge and linking new knowledge.
……..	3) Learners analyze from prior knowledge and new knowledge.
……..	4) The knowledge base is the old stage to learn something new.
……..	5) Show and compare what is right and wrong in the new contents.
……..	6) Debate analysis and summary.
……..	7) Use various materials and questions as examples during teaching.
……..	8) Shares ideas with friends and instructors through activities.
……..	9) Questions and answers to enhance retention.
……..	10) Encourage learners to do collaborate learning.
……..	11) Learners to the learning process. Difficulty to hard to find.
……..	12) Learners debate analysis summary.
……..	13) Learners share ideas. Activities in respect of its content. A question and answer. With friends and teachers make the students remember.
……..	14) Learners take action activities. And behave as intended.
……..	15) Learners learn problem solving methods of self.
……..	16) Learner adjusted behavior, the objectives set.
……..	17) Learner retention in the memory. And transfer of knowledge for students to apply new skills and knowledge associated with the prior knowledge.
……..	18) Learner and learning together summarize main ideas of the content.
……..	19)Learner conversation knowledge. Summary or review in order to have knowledge that the more sustainable.
……..	20) Learner performs activities such as exercise, supplements. Additional work assignments or lifting up to new situations. To help the students learn the skills.
……..	21) Learner’s repeat performance is reviewed and a new situation than ever to learn to practice the transfer of learning. And to verify that knowledge remains.
……..	22) A Learner evaluates their own learning.

1. Constructivism (Cont.)	
1.1	What do you think about the **'principles' of constructivism** which covers the contents in instruction? For example:
Please selects your specify any suggestion in blank.	
……..	23) Learner evaluate by pre test/ dills and practices/ post test and doing practices.
……..	24) Learner creates meaning and understanding of self-checking.
……..	25) Learner knowledge creation is a process that occurs continuously and related to the procedure.
……..	26) Learner creation of knowledge by the discovery. Learner-centered. Self-directed learning.
……..	27) Learner self-knowledge with a combination of environmental resources, such as students with the knowledge, students with the instructor, students with learning. Learning the meaning of things.
……..	28) Learner's ability to develop their own. The goal of teaching and learning.
……..	29) Learner is set, or to participate in determining what to study and how their own learning.
……..	30) Learner judges that they have learned and will learn how their own learning.
……..	31) Learner has learned in the atmosphere of the class of Prof has to help each other.
……..	32) Learner has basic knowledge necessary for learning the topic.
……..	33) Learner with the basic knowledge necessary for learning the topic.
……..	34) Learner explores the knowledge generated by the exchange of ideas with others.
……..	35)Learner changes knowledge by bringing his knowledge to solve problems in practical situations.
……..	36) Learner Reflection on the knowledge used in different situations, both within and outside the school building.
……..	37) Learner has an important role in knowledge creation and self-directed learning.
……..	38) Learner considers prior knowledge. Beliefs and vision of the school motto of teaching and learning activities.
……..	39) Learner errors lead to incorrect beliefs of the students used to benefit learning.
……..	40) Learner has learned complex task, skills and knowledge needed. The action manually.
……..	41) Learner encourage students independently to search for knowledge, planning and operations to achieve their learning goals.
1. Constructivism (Cont.)	
1.1	What do you think about the**'principles' of constructivism** which covers the contents in instruction? For example:
Please selects your specify any suggestion in blank.	
……..	42) Learner expressed that the media to know that students who learn to understand how different things.
……..	43) Linking learners' ideas by using hyperlinks.

……..	44) Instructors use various materials to speak of questions of teaching examples.
……..	45) Instructor preview compares what is right and wrong the new content.
……..	46) Instructors asked to encourage students to collaborate learning.
……..	47) Instructors praise students completed immediately after the activity.
……..	48) Instructor teaching and learning activities were held. The practice of speaking,writing or discussion.
……..	49) Instructors create environment looking to meet the students' behavior, such as providing tools for learners to act Laboratory asked to do exercises.
……..	50) Instructor, motivating students to take note of the progress of their own learning.
……..	51) Instructor guidance in the performance of activities or actions that the students have shown.
……..	52) Instructor to compliment expressed satisfaction and pleasure in work, or the actions the students.
…….	53) Instructor a behavior or measurement and evaluation of student performance based learning objectives set.
…….	54) Instructor evaluation of students use a variety of tests such as observation, recording, checking whether the behavioral task.
…….	55) Instructor evaluation of students by observing the students' questions. Students completed the exercise. Or the test before school and after school to improve learner does not understand.
……..	56) Instructor has many roles such as guiding the practice of students, etc., but not determined by the method of learning to learn.
……..	57) Instructor can interpret what he knows by his own previous experience.
……..	58) Instructor creates an atmosphere of learning, relaxing. Support learning and promote the knowledge of learners.
……..	59) Instructor encourages and recognizes the independence. Initiative of the students so that students can link ideas. Self-concept.
……..	60) Instructor encourages students to think critically by predicting creative problem solving and promote understanding about learning.
1. Constructivism (Cont.)	
1.1	What do you think about the**'principles' of constructivism** which covers the contents in instruction? For example:
Please selects your specify any suggestion in blank.	
……..	61) Instructor comments or feelings about lesson content and teaching strategies. To adjust teaching and learning activities in accordance with the characteristics and interests of learners.
……..	62) Instructor encouraged students to participate in discussions with both teachers and others. Discussion compromise understanding about learning.
……..	63) Instructor understanding the concepts of the students before they share their views on the concept.
……..	64) Instructor encourages students actions by asking questions that require thinking or ask open-ended questions to promote the ability of the inquiry of the students.
……..	65) Instructor activities for students to interact with or respond and allows

	students to review and reconcile assess understanding your ideas.
……..	66) Instructor creates experience to have the opportunity to argue with the hypothesis set and activates to have discussions about the dispute. To promote higher level thinking of Learner.
……..	67) Instructor to create situations for learners to the idea. Learner by asking questions and answers.
……..	68) Instructor relationship, or compare the learning concepts. To help the students to create a relationship between self-concepts.
…….	69) Instructor and students using the learning cycle for students to find answers about what they need to learn by themselves.
……..	70) Instructor of social interaction on the academic.
……..	71) Instructor of the reasons motivating the students, starting with what students already know.
……..	72) Instructor encouraged students to use multiple perspectives in presenting the meaning of the concept.
……..	73) Instructor to set the goals and objectives for their own learning.
……..	74) Instructor role as a director guiding the practice of facilitating the learning of students.
……..	75)Instructor context of learning opportunities, such as activities, tools and environments that promote thinking. Supervision and self-awareness.
……..	76) Instructor arranges a situation of learning content and work environment Skills related to the students by the reality.
1. Constructivism (Cont.)	
1.1	What do you think about the**'principles' of constructivism** which covers the contents in instruction? For example:
Please selects your specify any suggestion in blank.	
……..	77) Instructor promoted to solve the problem. Higher level thinking skills and deep understanding of the course.
……..	78) Instructor information from primary sources to submit an actual situation.
……..	79) Instructor encouraged students to create relationships between the concepts of learning about.
……..	80) Instructor facilitates the learning of students by providing advice. To work with others.
……..	81) Instructor evaluation of student learning according to the actual situation, while teaching and learning activities.
……..	82) Instructor developing understanding about the meaning of things. Over the course of behavior modification.
……..	83)Instructor selection and teaching strategies resolve misconceptions of students.
……..	84) Instructor attention to the thinking process and self-directed learners.
……..	85) Activating pre-knowledge about oneself through entry examination,Participation in games/activities, and questioning.
……..	86) Exchanging ideas and correcting mistakes through final examinations, answering, and chatting on bulletin boards.

……..	87) Linking learners' ideas by using hyperlinks.
……..	88) Creating experiences for learning new things before teaching new contents.
……..	89) Activating pre-knowledge about oneself through entry examination, participation in games/activities, and questioning.
……..	90) Exchanging ideas and correcting mistakes through final examinations, answering, and chatting on bulletin boards.
……..	91）Learners actively construct knowledge by building on their prior experiences and understanding.
……..	92 ） Knowledge is co-constructed through collaborative interactions and discussions among learners.
……..	93）Learning occurs through authentic, hands-on experiences and problem-solving activities.
……..	94）Learners actively construct knowledge through interactions and collaboration with their peers.
……..	95）Social interaction and dialogue play a crucial role in the co-construction of knowledge.
1. Constructivism (Cont.)	
1.1	What do you think about the**'principles' of constructivism** which covers the contents in instruction? For example:
Please selects your specify any suggestion in blank.	
……..	96 ） Knowledge construction is influenced by the socio-cultural context and community of practice.
……..	97 ） Problem-based learning tasks that require learners to actively construct knowledge.
……..	98）Group discussions and collaborative projects that promote social interaction and knowledge sharing.
……..	99）Authentic, real-world tasks that connect learning to vocational practice and industry standards.
……..	100 ） Use of technology tools and platforms that facilitate collaboration and knowledge construction.
……..	101）Enhanced learner engagement and motivation.
……..	102）Development of critical thinking and problem-solving skills.
……..	103）Promotion of collaboration and teamwork abilities.
……..	104）Application of knowledge to real-world vocational contexts.
Please writes your specify any suggestion. …… …… …… …… …… ……	

…… …… …… …… …… …… …… …… …… …… …… …… …… ……	
1. Constructivism (Cont.)	
1.2	What do you think about **'teaching-learning environments'** of contructivism theory?" For example:
Please selects your specify any suggestion in blank.	
……..	1) Learners.
……..	2) Instructors.
……..	3) learning environment.
……..	4) Checking their understanding.
……..	5) Reviewing prior knowledge before learning something new.
Please writes your specify any suggestion. …… …… …… …… …… ……	
1.3	"What about stages of **'teaching-learning activities/strategies'** of constructivism?" For example:
Please selects your specify any suggestion in blank.	
……..	1) Activate pre-knowledge.
……..	2) Learner self through a process of psychological self.
……..	3) Learner understand the problem, learner observed.
……..	4) Interpretation of links.
……..	5) Learner review prior knowledge before learning something new.
……..	6) Fine question.
……..	7) Learner seeking answers.
……..	8) Learner critical thinking skills and cause and effect method of self inquiry.
……..	9) Learner choose how to solve problems on their own.
……..	10) Learner exchange ideas with each other.
……..	11) Learner study with others.
……..	12) Students verify a discovery.

……..	13) Create their own knowledge.
……..	14) Faced with the problem and solve it by themselves.
……..	15) Link prior knowledge with Knowledge structure.
……..	16) Causing the students' cognitive skills.
……..	17) Intellectual thought processes.
……..	18) Link prior knowledge with knowledge structure.
1. Constructivism (Cont.)	
1.3	"What about stages of **'teaching-learning activities/strategies'** of constructivism?" For example:
Please selects your specify any suggestion in blank.	
……..	19) Causing the students' cognitive skills.
……..	20) Intellectual thought processes.
……..	21) Inquiry seeks to know the answer.
……..	22) Learner understands and verify the conclusions in solving the problem by discussing with students.
……..	23) Check students' understanding about the study.
……..	24) Transfer knowledge.
……..	25) The knowledge, skills, processes, and then learn to use in describing the decision to solve problems, link compares what the new knowledge with prior knowledge, evaluate the answers, system data or information obtained from the inquiry, presents conclusions and ideas of the group, summary of findings.
Please writes your specify any suggestion. …… …… …… …… …… ……	
1.4	"What do you think about**'teaching learning models** 'of the theory of contructivism theory?" For example:
Please selects your specify any suggestion in blank.	
……..	1)Self-learning is a learning technique which consists of 4 aspects as in perception.
……..	2) Collaborative learning and/or team-based learning.
……..	3) Learning cycle.
……..	4) Co-operative learning.
……..	5)Project-based learning' is an example of independent learning, and problem-based learning.
……..	6) Problem solving method.
……..	7) Situated learning.

……..	8) Group investigation.
……..	9) Inquiry method
……..	10) Independent Learning means learning is designed by students.
1. Constructivism (Cont.)	
1.3	"What about stages of **'teaching-learning activities/strategies'** of constructivism?" For example:
Please selects your specify any suggestion in blank.	
……..	11）The integration of online and offline learning modalities to enhance the learning experience.
……..	12）A combination of face-to-face instruction and digital technologies to support vocational learning.
……..	13）A flexible learning approach that allows learners to engage in both in-person and virtual learning activities.
……..	14）Integration of online and offline learning activities to promote knowledge construction.
……..	15）Use of technology tools and resources that support collaborative learning.
……..	16）Flexibility to accommodate different learning preferences and schedules.
……..	17）Providing opportunities for online collaboration and discussions.
……..	18）Designing offline activities that reinforce and apply online learning.
……..	19）Sequencing and scaffolding learning experiences across online and offline modalities.
……..	20）Learning management systems (LMS) for content delivery and organization.
……..	21）Collaboration tools for synchronous and asynchronous communication.
……..	22）Online discussion forums or platforms for knowledge sharing and peer interaction.
……..	23）Virtual simulations or virtual reality (VR) experiences for vocational skill development.
……..	24）Increased flexibility and accessibility for learners.
……..	25）Enhanced engagement and motivation through varied learning experiences.
……..	26）Opportunities for collaborative knowledge construction and peer interaction.
……..	27)Integration of technology for real-world vocational skill development.

1. Constructivism (Cont.)	
1.4	"What do you think about**'teaching learning models** 'of the theory ofcontructivism theory?" For example:
Please writes your specify any suggestion. …… …… …… …… …… …… ……	
2. Constructionism.	
2.1	"What do you think about**'principles'** of constructionism theory which covers the contents in instruction?" For example:
Please selects your specify any suggestion in blank.	
……..	1) Learning for intellectual creativity.
……..	2) Creation of self-knowledge does not derive from instructors.
……..	3) Learner-centered learning.
……..	4) Scientific learning method.
……..	5) Learning by doing.
……..	6) Recognition of learners' role as independent learners and creating their own understanding.
……..	7) Create active learning model so that learners have new knowledge and they encourage learners to be experts and able to create thinking model by themselves.
……..	8) Creative self-knowledge derives not from the instructor.
……..	9) Learner-centered learning.
……..	10) Science Method Learning.
……..	11) Learning by doing and making.
……..	12) Recognition of the role of students as creators of knowledge. Understanding of things by creating their own knowledge of the students.
……..	13) Linking ideas to help students to make meaning of what was to learn more. When used in combination with the knowledge that already exists, it will be able to think continuously.
…...	14)Instructors will be a model of active learning. Never stop learning something new. To help the students see a concrete example. At the same time, it encourages the students gradually Develop themselves to be experts on learning with. Help students select appropriate modes of thinking about them.
2. Constructionism (Cont.)	
2.1	"What do you think about**'principles'** of constructionism theory which covers the contents in instruction?" For example:
Please selects your specify any suggestion in blank.	
…….	15) Instructors will be a model of active learning. Never stop learning something new. To help the students see a concrete example. At the same time, it encourages the students gradually Develop themselves to be experts on learning with. Help

	students select appropriate modes of thinking about themselves.
……..	16) Stimulate the thinking process. Exchange ideas with each other will help students with aptitude Have to work together harmoniously because of the opportunity to develop language Can understand together. And the knowledge that each person has to lose is arranged in the style of communication to understand language.
……..	17) Flow analysis, students learn their own. And presented the idea to exchange ideas.Each other.
……..	18) Building bodies of knowledge through the steps of comprehension, memorization, analysis and application by using supplementary activities and doing exercises after the lessons.
……..	19) Creating creativity, reflective thinking and initiative idea by inventing a piece of work, summarizing and designing an invention.
……..	20)Learning that emphasizes cooperative and interactive activities among learners.
……..	21)The process of collectively constructing knowledge through shared experiences and interactions.
……..	22)Working together in groups or teams to solve problems and achieve common learning goals.
……..	23)Clear learning objectives and outcomes.
……..	24)Alignment with vocational competencies and industry needs.
……..	25)Promoting active engagement and participation among learners.
……..	26)Fostering effective communication and collaboration skills.
……..	27)Enhanced critical thinking and problem-solving skills.
……..	28)Development of effective communication and teamwork abilities.
……..	29)Increased engagement and motivation among learners.
……..	30)Promotion of knowledge construction through discussions and shared experiences.
……..	31)Establishing clear expectations and guidelines for collaborative work.
……..	32)Providing opportunities for structured discussions and reflection.
……..	33)Encouraging active listening and respectful communication.
……..	34)Observations of group interactions and participation.
2. Constructionism (Cont.)	
2.1	"What do you think about**'principles'** of constructionism theory which covers the contents in instruction?" For example:
Please selects your specify any suggestion in blank.	
……..	35)Individual or group reflections on the collaborative process.
……..	36)Assessments of the quality of the final product or outcome.
……..	37)Peer evaluations or feedback on individual contributions.
……..	38)The active process of constructing new knowledge through reflection, critical thinking, and problem-solving.
……..	39)The integration and application of existing knowledge to new and authentic vocational situations.
……..	40)The collaborative creation and refinement of knowledge through interactions with others.

……..	41)Encouraging learner reflection and metacognition.
……..	42)Promoting problem-solving and critical thinking skills.
……..	43)Providing opportunities for inquiry-based learning and exploration.
……..	44)Facilitating collaborative discussions and knowledge sharing.
……..	45)Enhancing critical thinking and deeper understanding through collaborative discussions and debates.
……..	46)Promoting the sharing and synthesis of different perspectives and experiences.
……..	47)Fostering the co-construction and refinement of knowledge through collaborative projects.
……..	48)Performance-based assessments (e.g., projects, portfolios, practical exams).
……..	49)Reflections or metacognitive assessments on the learning process.
……..	50)Peer assessments or evaluations of collaborative knowledge construction.
……..	51)Assessments of the application and transfer of knowledge to real-world vocational contexts.
……..	52)The ability to apply knowledge and skills acquired in one context to another context within the same domain.
……..	53)The ability to adapt and transfer learning to new and unfamiliar situations in vocational practice.
……..	54)The integration of theoretical knowledge and practical skills to solve real-world vocational problems.
……..	55)Relevance of learning content to vocational practice.
……..	56)Opportunities for hands-on application and practice.
……..	57)Supportive learning environment that mirrors real-world vocational contexts.
……..	58)Collaboration and interaction with peers and industry professionals.
……..	59)Connecting learning to real-world vocational contexts and applications.
……..	60)Providing opportunities for authentic problem-solving and decision-making.
……..	61)Encouraging reflection and metacognitive thinking to promote transferability.
……..	62)Integrating collaborative and cooperative learning experiences.
2. Constructionism (Cont.)	
2.1	"What do you think about**'principles'** of constructionism theory which covers the contents in instruction?" For example:
Please selects your specify any suggestion in blank.	
……..	63)Enhances critical thinking and problem-solving skills through discussions and collective knowledge construction.
……..	64)Promotes the application and adaptation of knowledge and skills through peer feedback and support.
……..	65)Fosters the development of professional communication and teamwork skills.
……..	66)Performance-based assessments (e.g., projects, simulations, practical exams).
……..	67)Portfolios or reflective journals showcasing application of knowledge and skills in vocational contexts.
……..	68)Workplace assessments or internships where learners apply their learning in real-world vocational settings.
……..	69)Self-assessment and reflection on the transferability of knowledge and skills.
……..	70)Overcoming the gap between the learning environment and vocational practice.
……..	71)Addressing learner resistance or lack of motivation to transfer knowledge and skills.

……..	72)Navigating the complexity of real-world vocational challenges and constraints.
……..	73)Assessing the transferabilityof knowledge and skills in authentic vocational contexts.

Please writes your specify any suggestion.

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2. Constructionism (Cont.)	
2.2	"What do you think about **'teaching-learning environments'**of constructinism theory?" For example:

Please selects your specify any suggestion in blank.

……..	1) Learners.
……..	2) Method.
……..	3) Instructors.
……..	4) Environment.

Please writes your specify any suggestion.

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……

2. Constructionism.	
2.3	"What about stages of **'teaching-learning activities/strategies'** of constructinism?" For example:

Please selects your specify any suggestion in blank.

……..	1) Activate Pre-knowledge.
…….	2) Learner self through a process of psychological self. Initiated reviews. Use prior knowledge to guide perception. Or solve problems on their own

	students appreciate And their aptitudes.
…….	3) Learner Understand the problem.
…….	4) Learner observed. Interpretation of links. Compared with the original concept by understanding. Led to the inquiry. Check their understanding.
…….	5) Learner review prior knowledge before learning something new.
……..	6) Fine Question.
…….	7) Learner seeking answers. To reduce cognitive conflict with knowledge. Skills used in this study.
…….	8) Learner critical thinking skills and cause and effect method of self inquiry.
…….	9) Learner choose how to solve problems on their own.
…….	10) Learner exchange ideas with each other.
…….	11) Learner study with others.
…….	12) Students verify a discovery.
2. Constructionism.(Cont.)	
2.3	"What about stages of **'teaching-learning activities/strategies'** of constructinism?"
Please selects your specify any suggestion in blank.	
…….	13)Check learners understand. Create their own knowledge. Study findings were analyzed and interpreted to a conclusion and instructor should encourage student reflection and reconciliation of conflict. About the findings and concepts of the various groups. The answer can be summarized as a social agreement.
……..	14) Faced with the problem and solve it by themselves.
……..	15) Link prior knowledge with Knowledge structure, causing the students' cognitive skills, intellectual thought processes.
……..	16) The process step instruction to solve problems for students.
……..	17) Inquiry seeks to know the answer.
……..	18) Learner understands and verify the conclusions in solving the problem by discussing with students.
……..	19) Check students' understanding about the study.
……..	20) Transfer Knowledge.
……..	21) The knowledge, skills, processes, and then learn to use in describing the decision to solve problems.
……..	22) Link compares what the new knowledge with prior knowledge. Reasoning in understanding and negotiating with others to create their own meaning or explanation of possible about what is perceived to warm themselves.
……..	23) Link compares what the new knowledge with prior knowledge. Reasoning in understanding and negotiating with others to create their own meaning or explanation of possible about what is perceived to warm themselves.
……..	24) Link compares what the new knowledge with prior knowledge. Reasoning in understanding and negotiating with others to create their own meaning or explanation of possible about what is perceived to warm themselves.
……..	25) System data or information obtained from the inquiry.

……..	26) Presents conclusions and ideas of the group.
……..	27) Summary of findings.
Please writes your specify any suggestion. …… …… …… …… ……	
2. Constructionism.(Cont.)	
2.4	"What do you think about**'teaching learning models** 'of the theory ofcontructinism theory?" For example:
Please selects your specify any suggestion in blank.	
……..	1) The receptive style learning.
……..	2) Creative thinking-learning.
……..	3) The discovery style learning, 'group process learning' is an example of independent learning.
……..	4) Avoidance learning.
…….	5) Participant learning.
…….	6) Independent learning.
……..	7) The discover style learning.
……..	8) 'Group Process Learning' is an example of independent learning.
……..	9) Avoidance learning.
……..	10) Participant learning.
……..	11) Dependent learning.
……..	12) Independent learning.
Please writes your specify any suggestion. …… …… …… …… …… …… ……	

Appendix C Questionnaire I

Instruments: First Round: Brainstorming

Questionnaire I

Faculty of Technical Education
Rajamangala University of Technology Thanyaburi (RMUTT)
39 Moo 1,Rangsit-Nakhon Nayok Road
Klong Hok, Khlong Luang, Pathum Thani
Postal Code 12110, Thailand
Date:……

Dear ……

My name is Mr. Biquan Mo. The researcher is a Ph.D. student in the Vocational Education Program in the Faculty of Technical Education of the Rajamangala University of Technology Thanyaburi, RMUTT. The research working on The dissertation entitled: Development of A Learning Model for Blended Collaborative Knowledge Construction in Vocational Education. The research is in the process of developing the research tools and collecting the data. Seventeen experts will be interviewed in four rounds to collect data using the Delphi technique. First, semi-structured interviews were employed, and data were analyzed using content analysis. Then the results were used to develop the rating scale questionnaires, which will be used for collecting data in the second and third rounds. The second and third rounds aim to confirm the opinions and answers provided by those experts to explore the conclusions and the agreement among experts. These are essential for course design and development, in which electronic media will be used.

This questionnaire was constructed based on the content analysis of the first round. As a result, all experts are kindly asked to please answer the questionnaire. The data obtained will be analyzed by median, mode, and interquartile range. The opinions and answers will be kept secret, and the results will be reported as a whole group.

To respond appropriately to the questionnaire, consider and provide the numbers *1*, *2*, *3*, *4*, and *5* to each item for approval, while five is the highest and one is the lowest.

Thank you very much for your kind co-operation.

Yours sincerely,

Mr. Biquan Mo

Questionnaire I on

Development of A Learning Model for Blended Collaborative Knowledge Construction in Vocational Education.

Instructions:

1) Please tick (/) in each blank according to your level of opinion.
2) If you think the stages of the teaching-learning procedure, components, and models of each theory need to be corrected, the researcher would like to adjust or improve this questionnaire with the greatest thanks.

Principle:		Opinion				
Constructivism (Learning by doing approach)	Constructionism (Social context)	5	4	3	2	1
1. Checking previous knowledge before learning new things. (Learners)	1. Learning for wit creation. (Learners)					
2. Encouraging learners to ask questions that require thinking to promote learners to exchange opinions by using teaching methods is called the learning cycle. (Instructors)	2. Learning by practicing or building things up. (Learners)					
3. Learning by creating the meaning of things and checking the understanding. (Learners)	3. Creating an organization knowledge on one's own, not from the instructors. (Learners)					
4. Emphasizing in child-centered model to be self-controlled learning. (Learners)	4. Exchanging ideas, encouraging and improving mistakes of one another. (Learners)					
5. Creating a learning atmosphere. (Instructors)	5. Linking ideas will help learners to create the meanings of the things to be learned. (Learners)					
6. Self-knowledge searching according to competence and previous experience. (Learners)	6. Analyzing the learning procedures and letting the learners present his/her ideas to exchange them with one another. (Learners)					

Principle (Cont.):		Opinion				
Constructivism (Learning by doing approach)	Constructionism (Social context)	5	4	3	2	1
7. Problem-solving or investigation to reduce contradiction in ideas and to be	7. teachers'promotions in learning new things to create concrete examples to help learners gradually develop themselves to be experts in					

important for assimilation. (Learners)	learning and can choose the most suitable thinking models for themselves. (Learners)					
8. Creating organization knowledge by discovery procedure. (Learners)	8. Building experiences from work and problem-solving with the instructors, which helps learners to learn from the things that adults and instructors have done, and one thing that instructors do is pay attention to the problems until they understand them completely. (Learners)					
9. Using the knowledge that was already learned in other contexts properly. (Learners)						
Stages of teaching-learning activities:						
1. Activate pre-knowledge.	1. Motivate learning					
2. Finding settled questions.	2. Activate pre-knowledge					
3. Knowledge transfer.	3. Change thinking					
	4. Transfer thinking					
Teaching-learning environments:						
1. Instructors	1. Instructors					
2. Learners	2. Learners					
3. Surroundings	3. Surroundings					
4. Knowledge Resources	4. Knowledge Resources					
Teaching-learning models:						
1. Self-learning	1. Brainstorms for project-based.					
2. Co-operative learning	2. Planning their learning.					
3. Project-based learning	3. Learning by doing					
4. Problem-based learning	4. New knowledge					
5. Situated learning	5. Presentation					
6. Group investigation	6. Learning assessment					
7. Inquiry method	7. Modify actions					

Appendix D.

Instruments: Second Round: Evaluation

Questionnaire II

Faculty of Technical Education
Rajamangala University of Technology Thanyaburi (RMUTT)
39 Moo 1,Rangsit-Nakhon Nayok Road
Klong Hok, Khlong Luang, Pathum Thani
Postal Code 12110, Thailand

Date:……..……

Dear …….

My name is Mr. Biquan Mo. The researcher is a Ph.D. student in the Vocational Education Program in the Faculty of Technical Education of the Rajamangala University of Technology Thanyaburi,RMUTT.The research working on The dissertation entitled: *Development of A Learning Model for Blended Collaborative Knowledge Construction in Vocational Education.* I am in the process of developing my research tools and collecting my data. Seventhteen experts will be interviewed 3 rounds to collect data by using Delphi technique. First, the semi- structure interviews were employed and data were analyzed by using content analysis. Then the results were used to develop the rating scale questionnaires which will be used for collecting data in the second and the third rounds. The purpose of the second and the third rounds is to confirm the opinions and answers which were provided by those experts to explore the conclusions and the agreement among experts. These are essential for course design and development which electronic media will be used.

This questionnaire was constructed based on the content analysis of the first round. As a result, all experts are kindly asked to please answer the questionnaire. Then data obtained will be analyzed by median, mode, and interquartile range. Your opinions and answers will be kept secret, and the results will be reported as a whole group.

To respond appropriately to the questionnaire, you are asked to consider and provide the number *1, 2, 3, 4,* and *5* to each item for your approval; while 5 is highest and 1 is lowest.

Thank you very much for your kind co-operation.

Your sincerely,

Mr. Biquan M

Questionnaire II on

Development of A Leaning Model for Blended Collaborative Knowledge Construction in Vocation Education:

1） Please make a tick (/) in each blank according to your level of opinion.

2） If you think that the stages of teaching – learning procedure, components and models of each theory are incorrect, the researcher would like you to adjust or improve this questionnaire with greatest thanks.

Gagne's theory	Constructivism	Constructionism	A Leaning Model for Blended Collaborative Knowledge Construction in Vocation Education	Opinion				
				5	4	3	2	1
1.1 Principle 1.1.1 Creating teaching criterion learners' external conditions. (Instructors) 1.1.2 Creating promotion in learning events. (Instructor) (Instructors) 1.1.3 Appointing criterion according to experience step by step. (Instructors) 1.1.4 Using teaching procedure which have suitable systems, regulations and elasticity. (Instructors)	2.1 Principle 2.1.1 Checking previous knowledge before learning new things. (Learners) 2.1.2 Encouraging learners to ask questions which required thinking to promote learners to exchange opinions by using teaching methods which called learning cycle. (Instructors) 2.1.3 Learning by creating the meaning of things and checking the understandings. (Learners) 2.1.4 Emphasizing in child-centered model to be self-controlled learning. (Learners)	3.1 Principle 3.1.1 Learning for wit creation. (Learners) 3.1.2 Learning by practicing or building things up. (Learners) 3.1.3 Creating organization knowledge on one's own not from the instructors. (Learners) 3.1.4 Exchanging ideas, encouraging and improving mistakes of one another. (Learners) 3.1.5 Linking ideas will help learners to create the meanings of the things to be learned. (Learners)	4.1 Principle 4.1.1 Creating situations, organization knowledge from experience. (Instructors) 4.1.2 Encouraging learners to originate learning. (Instructors) 4.1.3 Creating atmosphere of opinions exchanging. (Instructors) 4.1.4 Linking learners' ideas. (Instructors) 4.1.5 Creating experience of learning new things. (Instructors)					

(Continue)

Gagne's theory	Constructivism	Constructionism	A Leaning Model for Blended Collaborative	Opinion				
				5	4	3	2	1

			Knowledge Construction in Vocation Education					
1.1.5 Creating organization knowledge from experience arrangement. (Instructors) 1.1.6 Effective learning obtained from appointing instructional events. (Learners) 1.1.7 Having basic knowledge in comprehensive level and being able to solve the problems. (Learners) 1.1.8 Ability in creating thinking, reflexive thinking and initiation thinking. (Learners)	2.1.5 Creating learning atmosphere. (Instructors) 2.1.6 Self-knowledge searching according tocompetence and previous experience. (Learners) 2.1.7 Problem solving or investigation to reduce contradiction in ideas and to be important for assimilation. (Learners) 2.1.8 Creating organization knowledge by discovery procedure. (Learners) 2.1.9 Using knowledge which was already learned in other contexts properly. (Learners) 2.2 Stages of teaching-learning activities. 2.2.1 Activate pre-knowledge. 2.2.2 Finding settled questions.	3.1.6 Analyzing learning procedure and let the learners present his/her ideas to exchange them to one another. (Learners) 3.1.7 Teachers' promotions in learning new things to create concrete examples to help learners gradually develop themselves to be experts in learning and can choose the most suitable thinking models for themselves. (Learners) 3.1.8 Building experiences from work and problem solving with the instructors which help learners to learn from the things that adults and instructors have done, and one thing that instructors do is paying attention to the problems until they understand them completely. (Learners)	4.2 Stages of teaching-learning activities. 4.2.1 Activate pre-knowledge on one's own. 4.2.2 Exchange ideas and improving mistakes. 4.2.3 Building organization knowledge by ways of understanding, memorizing, analyzing and transfer. 4.2.4 Creating ideas, reflexive thinking and initiate thinking.					

(Continue)

Gagne 's theory	Constructivism	Constructionism	A Leaning Model for Blended Collaborative Knowledge Construction in Vocation Education	Opinion				
				5	4	3	2	1
1.2 Stages of teaching-learning activities.	2.2.3 Knowledge transfer.	3.2 Stages of teaching-learning activities.	4.3 Components of teaching-learning management.					

1.2.1 Stimulating and controlling interests. 1.2.2 Informing the expected learning results to the learners. 1.2.3 Creatingsituations to encourage learners to be interested in creating ways of thinking. 1.2.4 Giving useful advice in learning. 1.2.5 Reverse management. 1.2.6 Assessment practice. 1.2.7 Transfer abilities arrangement. 1.2.8 Originating memory.	2.3 Components of teaching-learning management. 2.3.1 Instructors 2.3.2 Learners 2.3.3 Surroundings 2.3.4 Knowledge resources 2.4 Teaching-learning models. 2.4.1 Self-learning 2.4.2 Co-operative learning 2.4.3 Project-based learning 2.4.4 Problem-based learning 2.4.5 Situated learning 2.4.6 Group investigation 1.4.7 Inquiry method	3.2.1 Motivate learning. 3.2.2 Activate pre-knowledge. 3.2.3 Change thinking. 3.2.4 Transfer thinking. 3.3 Components of teaching-learning management. 2.3.1 Instructors 2.3.2 Learners 2.3.3 Surroundings 2.3.4 Knowledge resources 3.4 Teaching-learning models. 3.4.1 Brainstorms for project based. 3.4.2 Planning of their own learning. 3.4.3 Learning by doing 3.4.4 New knowledge	4.3.1 Learners 4.3.2 Instructors 4.3.3 Stimulates 4.3.4 Respond behaviors 4.3.5 Surroundings 4.3.6 Tools or equipments 4.4 Teaching-learning models. 4.4.1 Encouraging interests. 4.4.2 Informing expected learning results to learners. 4.4.3 Building conditions to arouse interests to give rise to learning procedure. 4.4.4 Giving useful advice for learning. 4.4.5 Finding answers and altering ideas.					

(Continue)

Gagne ’s theory	Constructivism	Constructionism	A Leaning Model for Blended Collaborative Knowledge Construction in Vocation Education	Opinion				
				5	4	3	2	1
1.2.9 Transfer. 1.3 Components of teaching-learning management. 1.3.1 Instructors 1.3.2 Learners		3.4.5 Presentation 3.4.6 Learning assessment 3.4.7 Modify actions	4.4.6 Finding own wit thinking and abilities to transfer knowledge.					

1.3.3 Stimulates 1.3.4 Respond behaviors 1.4 Teaching-learning models. 1.4.1 Signals learning 1.4.2 Chaining 1.4.3 Verbal association 1.4.4 Discrimination learning 1.4.5 Concept learning 1.4.6 Rule learning 1.4.7 Problem solving								

Appendix E.

Instruments: Third Round: Re-Evaluation

Questionnaire III

Faculty of Technical Education
Rajamangala University of Technology Thanyaburi (RMUTT)
39 Moo 1,Rangsit-Nakhon Nayok Road
Klong Hok, Khlong Luang, Pathum Thani
Postal Code 12110, Thailand

Date:……..……

Dear …….

My name is Mr. Biquan Mo. The researcher is a Ph.D. student in the Vocational Education Program in the Faculty of Technical Education of the Rajamangala University of Technology Thanyaburi,RMUTT.The research working on The dissertation entitled: *Development of A Learning Model for Blended Collaborative Knowledge Construction in Vocational Education*. I am in the process of developing my research tools and collecting my data. Seventhteen experts will be interviewed 3 rounds to collect data by using Delphi technique. First, the semi- structure interviews were employed and data were analyzed by using content analysis. Then the results were used to develop the rating scale questionnaires which will be used for collecting data in the second and the third rounds. The purpose of the second and the third rounds is to confirm the opinions and answers which were provided by those experts to explore the conclusions and the agreement among experts. These are essential for course design and development which electronic media will be used.

This questionnaire was constructed based on the content analysis of the second round. As a result, all experts are kindly asked to please answer the questionnaire. Then data obtained will be analyzed by median, mode, and interquartile range. Your opinions and answers will be kept secret, and the results will be reported as a whole group.

To respond appropriately to the questionnaire, you are asked to consider and provide the number *1, 2, 3, 4,* and *5* to each item for your approval; while 5 is highest and 1 is lowest.

Thank you very much for your kind co-operation.

Your sincerely,

Mr. Biquan

Questionnaire III on

Development of A Leaning Model for Blended Collaborative Knowledge Construction in Vocation Education

Instructions:

1） Please make a tick (/) in each blank according to your level of opinion.

2） If you think that the stages of teaching – learning procedure, components and models of each theory are incorrect, the researcher would like you to adjust or improve this questionnaire with greatest thanks.

Gagne's theory	Constructivism	Constructionism	A Leaning Model for Blended Collaborative Knowledge Construction in Vocation Education	Opinion				
				5	4	3	2	1
1.1 Principle 1.1.1 Creating teaching criterion learners' external conditions. (Instructors) 1.1.2 Creating promotion in learning events. (Instructor) (Instructors) 1.1.3 Appointing criterion according to experience step by step. (Instructors) 1.1.4 Using teaching procedure which have suitable systems, regulations and elasticity. (Instructors) 1.1.5 Creating organization knowledge from experience arrangement. (Instructors) 1.1.6 Effective learning obtained from appointing instructional events. (Learners) 1.1.7 Having basic knowledge	2.1 Principle 2.1.1 Checking previous knowledge before learning new things. (Learners) 2.1.2 Encouraging learners to ask questions which required thinking to promote learners to exchange opinions by using teaching methods which called learning cycle. (Instructors) 2.1.3 Learning by creating the meaning of things and checking the understandings. (Learners) 2.1.4 Emphasizing in child-centered model to be self-controlled learning. (Learners) 2.1.5 Creating learning atmosphere. (Instructors) 2.1.6 Self-knowledge searching according to competence and previous experience. (Learners) 2.1.7 Problem solving or investigation to reduce contradiction in ideas and	3.1 Principle 3.1.1 Learning for wit creation. (Learners) 3.1.2 Learning by practicing or building things up. (Learners) 3.1.3 Creating organization knowledge on one's own not from the instructors. (Learners) 3.1.4 Exchanging ideas, encouraging and improving mistakes of one another. (Learners) 3.1.5 Linking ideas will help learners to create the meanings of the things to be learned. (Learners) 3.1.6 Analyzing learning procedure and let the learners present his/her ideas to exchange them to one another. (Learners)	4.1 Principle 4.1.1 Creating situations, organization knowledge from experience. (Instructors) 4.1.2 Encouraging learners to originate learning. (Instructors) 4.1.3 Creating atmosphere of opinions exchanging. (Instructors) 4.1.4 Linking learners' ideas. (Instructors) 4.1.5 Creating experience of learning new things. (Instructors)					

in comprehensive level and being able to solve the problems. (Learners)	to be important for assimilation. (Learners)							

(Continue)

Gagne's theory	Constructivism	Constructionism	A Leaning Model for Blended Collaborative Knowledge Construction in Vocation Education	Opinion				
				5	4	3	2	1
1.1.8 Ability in creating thinking, reflexive thinking and initiation thinking. (Learners) 1.2 Stages of teaching-learning activities. 1.2.1 Stimulating and controlling interests. 1.2.2 Informing the expected learning results to the learners. 1.2.3 Creating situations to encourage learners to be interested in creating ways of thinking. 1.2.4 Giving useful advice in learning. 1.2.5 Reverse management. 1.2.6 Assessment practice. 1.2.7 Transfer abilities arrangement. 1.2.8 Originating memory. 1.2.9 Transfer.	2.1.8 Creating organization knowledge by discovery procedure. (Learners) 2.1.9 Using knowledge which was already learned in other contexts properly. (Learners) 2.2 Stages of teaching-learning activities. 2.2.1 Activate pre-knowledge. 2.2.2 Finding settled questions. 2.2.3 Knowledge transfer.	3.1.7 Teachers' promotions in learning new things to create concrete examples to help learners gradually develop themselves to be experts in learning and can choose the most suitable thinking models for themselves. (Learners) 3.1.8 Building experiences from work and problem solving with the instructors which help learners to learn from the things that adults and instructors have done, and one thing that instructors do is paying attention to the problems until they understand them completely. (Learners) 3.2 Stages of teaching-learning activities. 3.2.1 Motivate learning. 3.2.2 Activate pre-knowledge. 3.2.3 Change thinking. 3.2.4 Transfer thinking.	4.2 Stages of teaching-learning activities. 4.2.1 Activate pre-knowledge on one's own. 4.2.2 Exchange ideas and improving mistakes. 4.2.3 Building organization knowledge by ways of understanding, memorizing, analyzing and transfer. 4.2.4 Creating ideas, reflexive thinking and initiate thinking.					

(Continue)

Gagne 's theory	Constructivism	Constructionism	A Leaning Model for Blended Collaborative Knowledge Construction in Vocation Education	Opinion				
				5	4	3	2	1
1.3 Components of teaching-learning management. 1.3.1 Instructors 1.3.2 Learners 1.3.3 Stimulates 1.3.4 Respond behaviors 1.4 Teaching-learning models. 1.4.1 Signals learning 1.4.2 Chaining 1.4.3 Verbal association 1.4.4 Discrimination learning 1.4.5 Concept learning 1.4.6 Rule learning 1.4.7 Problem solving	2.3 Components of teaching-learning management. 2.3.1 Instructors 2.3.2 Learners 2.3.3 Surroundings 2.3.4 Knowledge resources 2.4 Teaching-learning models. 2.4.1 Self-learning 2.4.2 Co-operative learning 2.4.3 Project-based learning 2.4.4 Problem-based learning 2.4.5 Situated learning 2.4.6 Group investigation 1.4.7 Inquiry method	3.3 Components of teaching-learning management. 2.3.1 Instructors 2.3.2 Learners 2.3.3 Surroundings 2.3.4 Knowledge resources 3.4 Teaching-learning models. 3.4.1 Brainstorms for project based. 3.4.2 Planning of their own learning. 3.4.3 Learning by doing 3.4.4 New knowledge 3.4.5 Presentation 3.4.6 Learning assessment 3.4.7 Modify actions	4.3 Components of teaching-learning management. 4.3.1 Learners 4.3.2 Instructors 4.3.3 Stimulates 4.3.4 Respond behaviors 4.3.5 Surroundings 4.3.6 Tools or equipments 4.4 Teaching-learning models. 4.4.1 Encouraging interests. 4.4.2 Informing expected learning results to learners. 4.4.3 Building conditions to arouse interests to give rise to learning procedure. 4.4.4 Giving useful advice for learning. 4.4.5 Finding answers and altering ideas. 4.4.6 Finding own wit thinking and abilities to transfer knowledge.					

Diagram chat	Opinion				
Figure 1 Similarities classified by ‘principles’	5	4	3	2	1

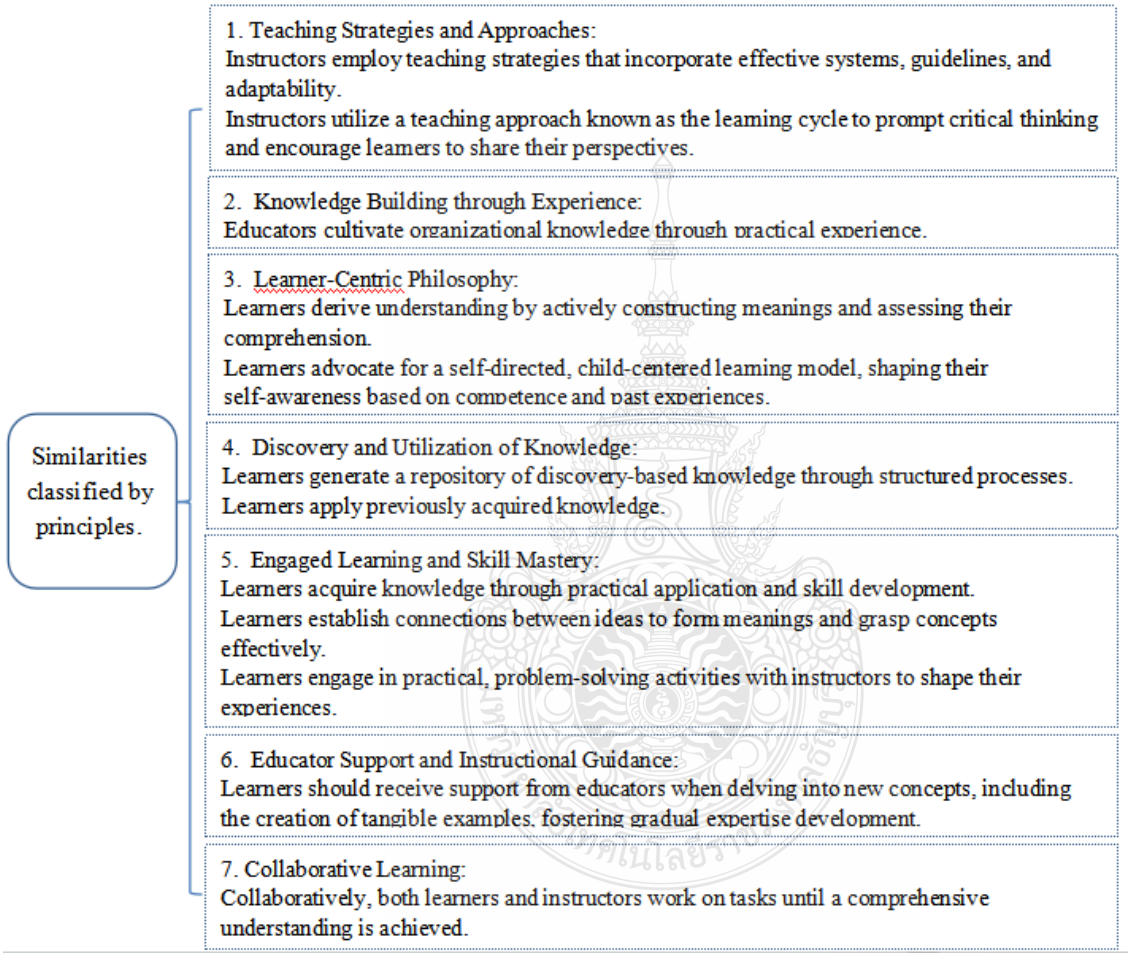


Diagram chat					Opinion	

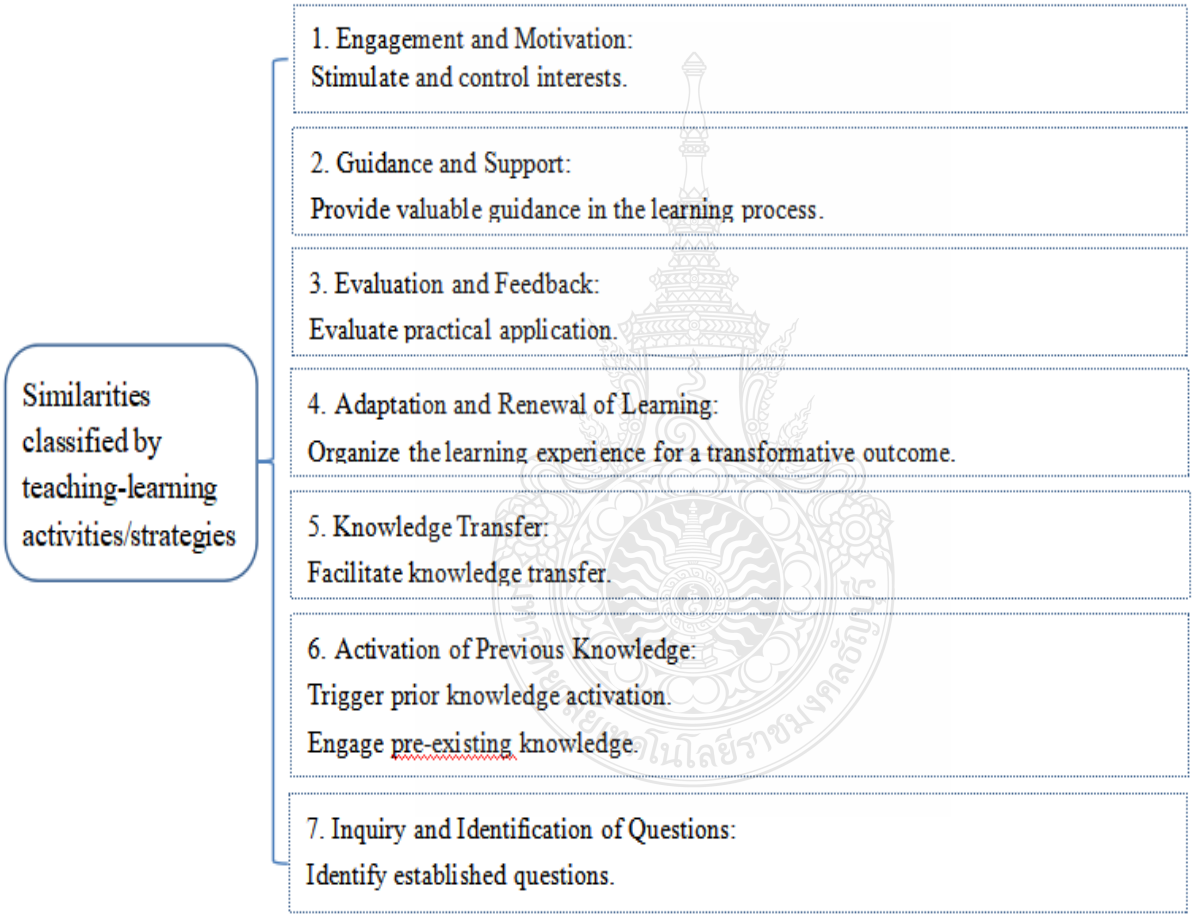
Figure 2 Similarities classified by 'teaching-learning activities/strategies'	5	4	3	2	1
					

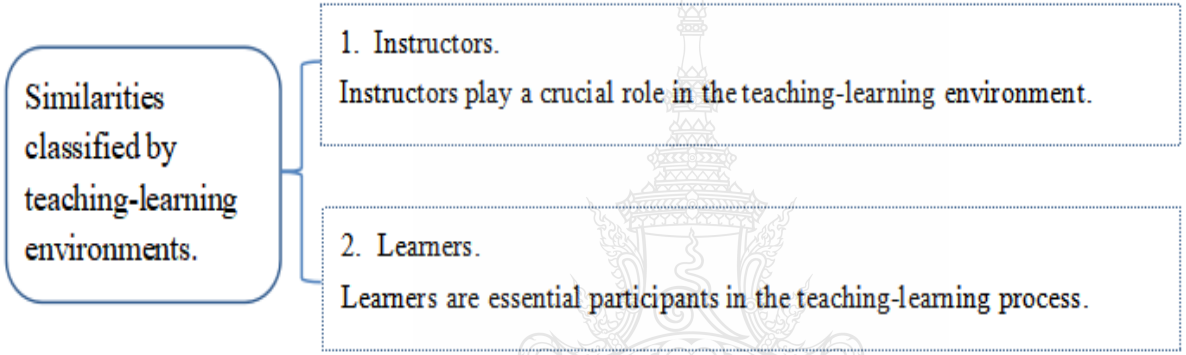
Diagram chat	Opinion				
Figure 3 Similarities classified by 'teaching-learning environments'	5	4	3	2	1
					

Diagram chat	Opinion				
Figure 4 Similarities classified by ‘teaching-learning models’	5	4	3	2	1

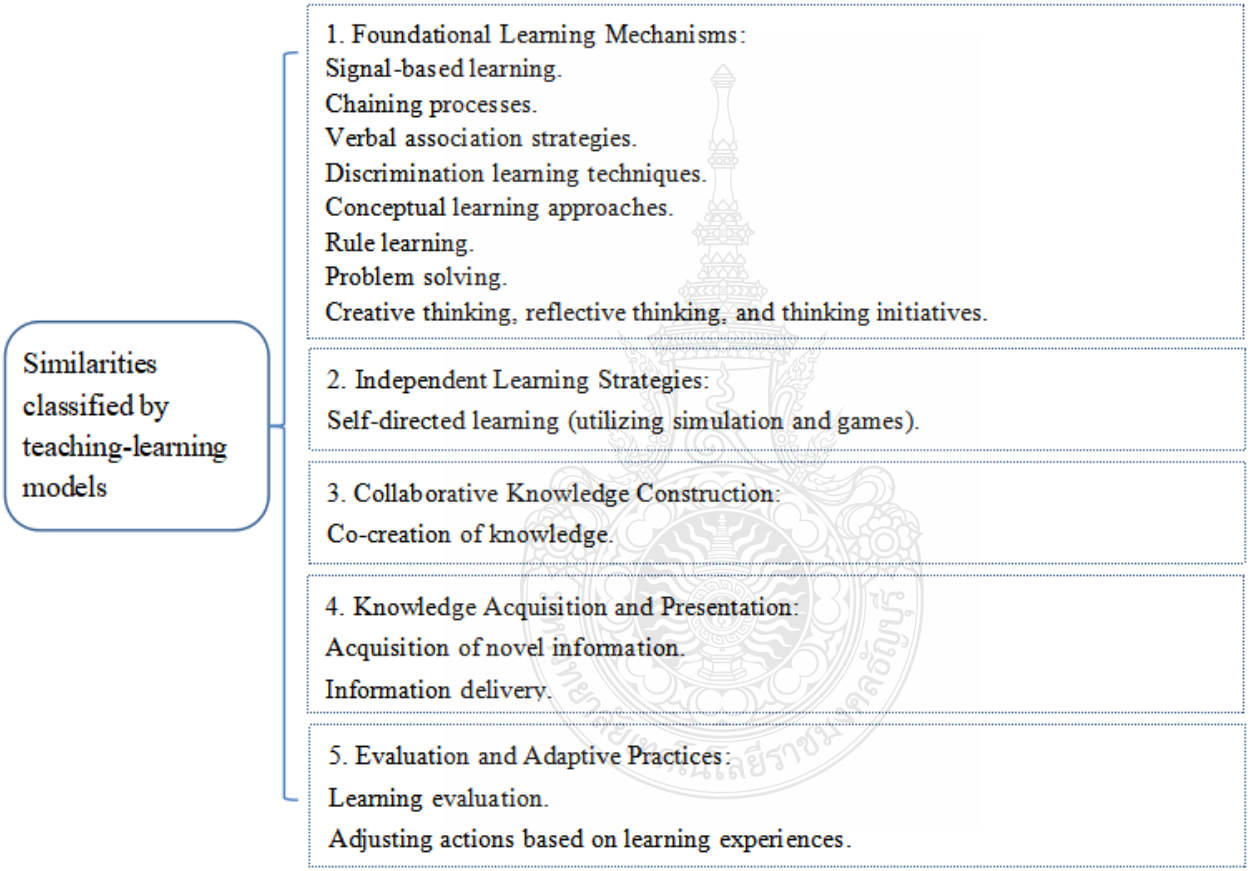

Similarities classified by teaching-learning models
1. Foundational Learning Mechanisms:
Signal-based learning.
Chaining processes.
Verbal association strategies.
Discrimination learning techniques.
Conceptual learning approaches.
Rule learning.
Problem solving.
Creative thinking, reflective thinking, and thinking initiatives.
2. Independent Learning Strategies:
Self-directed learning (utilizing simulation and games).
3. Collaborative Knowledge Construction:
Co-creation of knowledge.
4. Knowledge Acquisition and Presentation:
Acquisition of novel information.
Information delivery.
5. Evaluation and Adaptive Practices:
Learning evaluation.
Adjusting actions based on learning experiences.

Diagram chat	Opinion				
Figure 5 Differences classified by ‘principles’	5	4	3	2	1

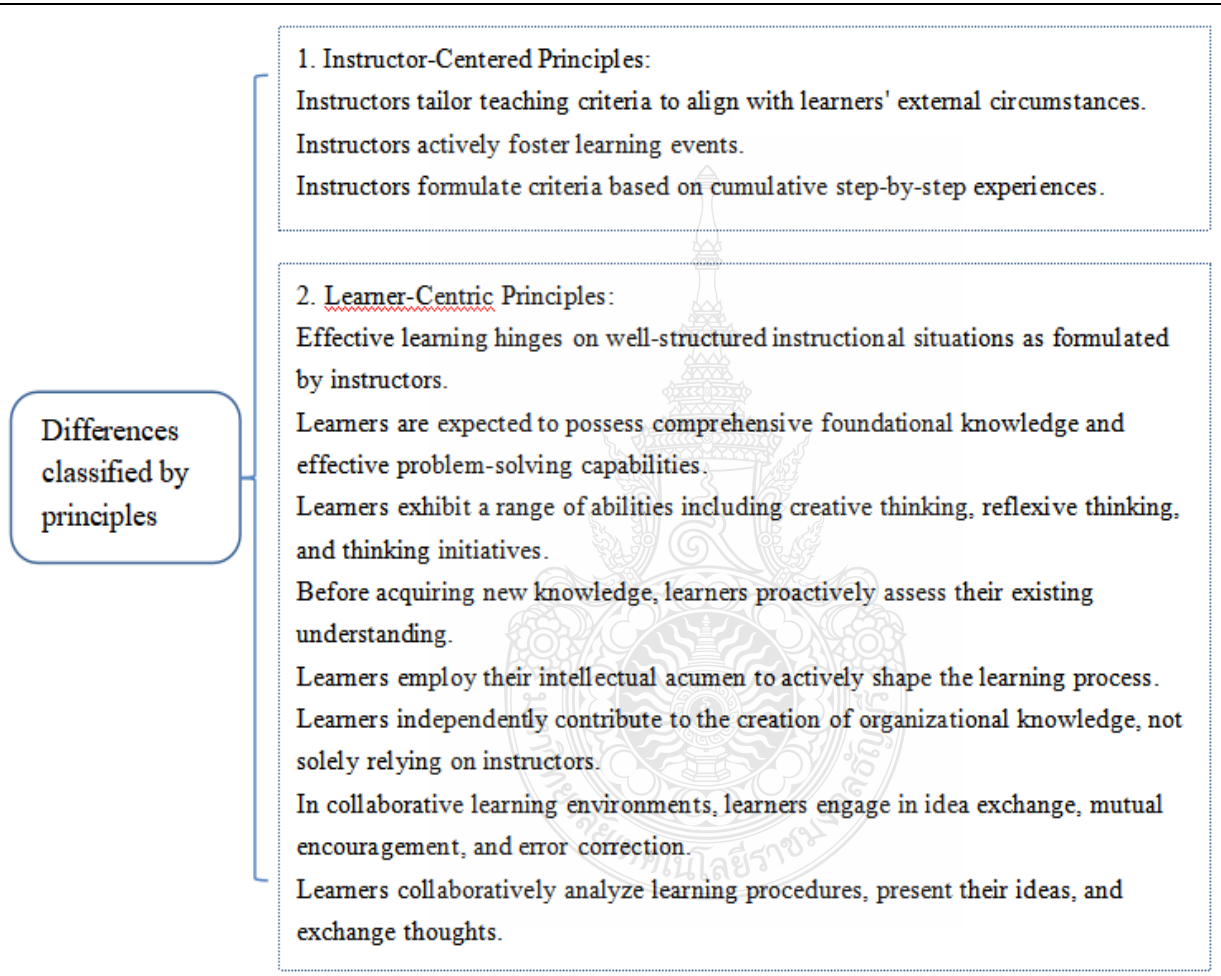


Diagram chat	Opinion				

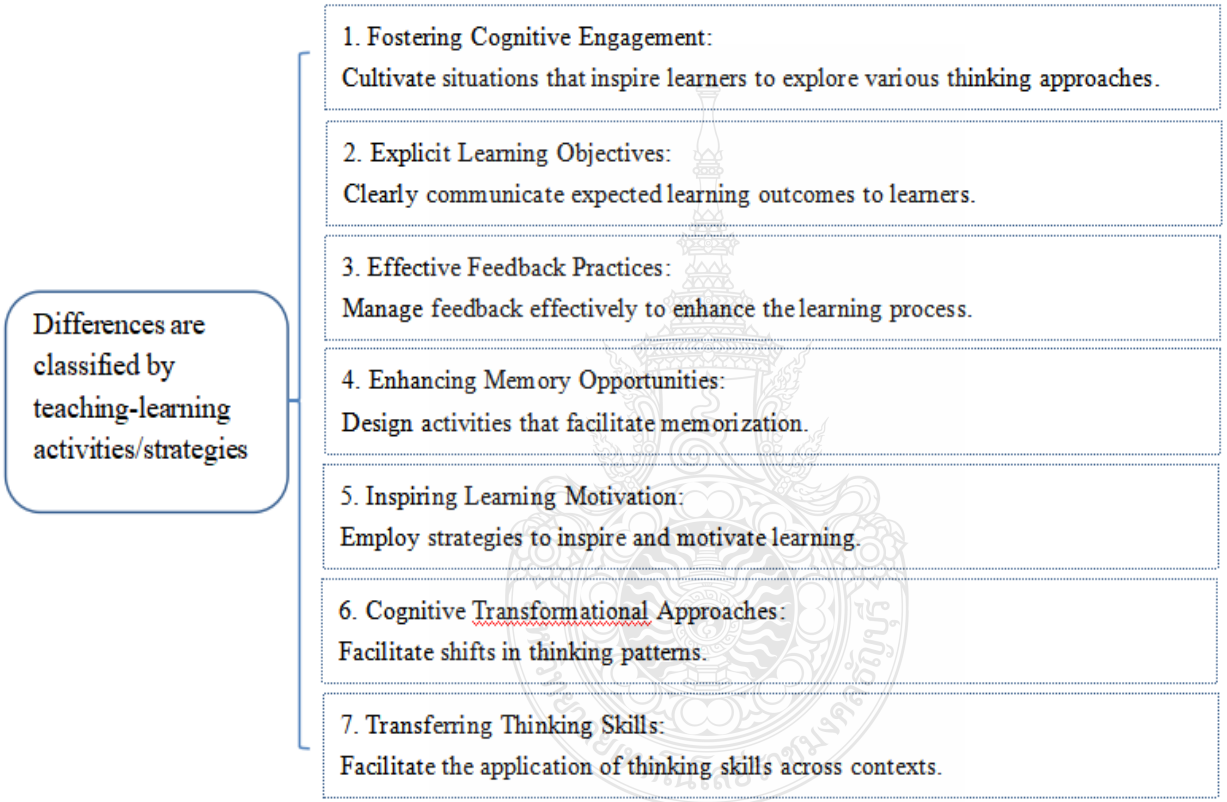
Figure 6 Differences classified by ‘teaching-learning activities/strategies’.	5	4	3	2	1
					

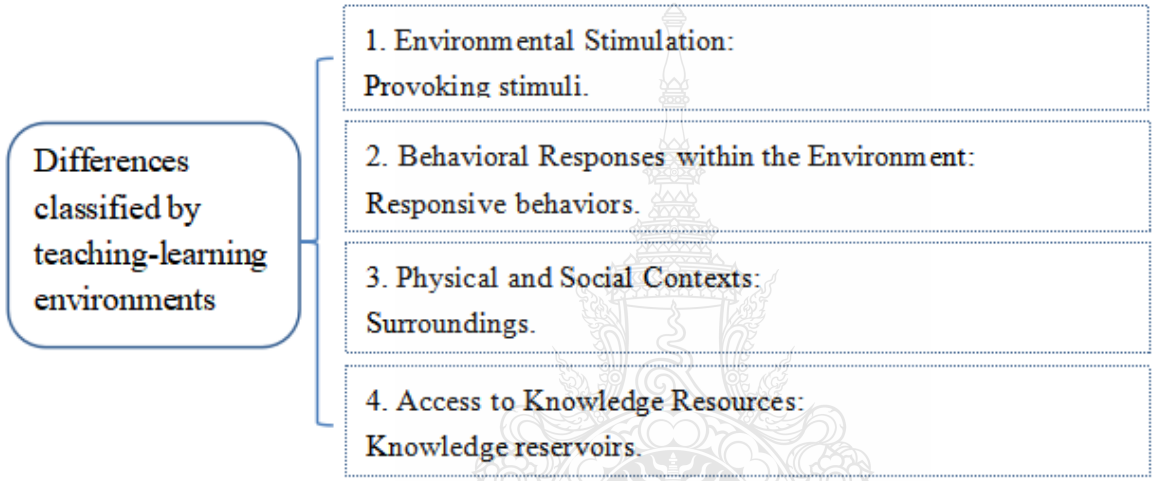
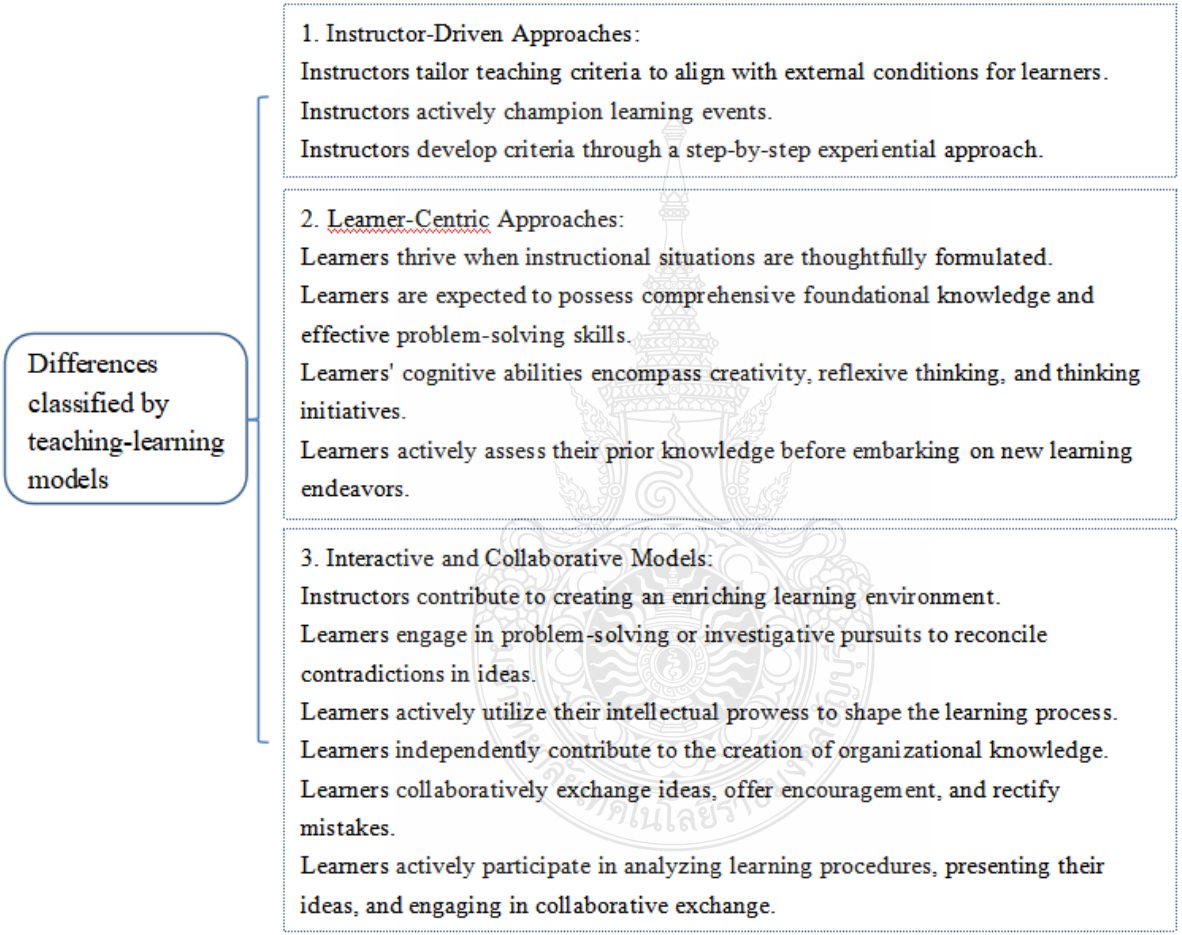
Diagram chat	Opinion				
Figure 7 Differences classified by 'teaching-learning environments'.	5	4	3	2	1
					

Diagram chat	Opinion				
Figure 8 Differences classified by teaching-learning models	5	4	3	2	1


Differences classified by teaching-learning models
1. Instructor-Driven Approaches:
Instructors tailor teaching criteria to align with external conditions for learners.
Instructors actively champion learning events.
Instructors develop criteria through a step-by-step experiential approach.
2. Learner-Centric Approaches:
Learners thrive when instructional situations are thoughtfully formulated.
Learners are expected to possess comprehensive foundational knowledge and effective problem-solving skills.
Learners' cognitive abilities encompass creativity, reflexive thinking, and thinking initiatives.
Learners actively assess their prior knowledge before embarking on new learning endeavors.
3. Interactive and Collaborative Models:
Instructors contribute to creating an enriching learning environment.
Learners engage in problem-solving or investigative pursuits to reconcile contradictions in ideas.
Learners actively utilize their intellectual prowess to shape the learning process.
Learners independently contribute to the creation of organizational knowledge.
Learners collaboratively exchange ideas, offer encouragement, and rectify mistakes.
Learners actively participate in analyzing learning procedures, presenting their ideas, and engaging in collaborative exchange.

Appendix F.

Instruments: Fourth Round: Resolution and Report

Questionnaire IV

Questionnaire IV

Teachers' Perceptions of the Relevance of the Learning Process Theory of the Blended Collaborative Knowledge Construction Learning Model

Domains	Confirmation (Percentage)	Disconfirmation (Percentage)	Reject (Percentage)
Principles:			
1.Creating situations and building experience by using concept map.**(83.0%)**			
2. Stimulating learners to learn by using music and images. **(87.7%)**			
3.Creating atmosphere suitable for exchanging opinions by using social media for instruction. **(62.3%)**			
4.Linking learners' ideas by using hyperlinks Linking learners' ideas by using hyperlinks. **(62.3%)**			
5.Creating experience to learn new things before teaching new contents. **(58.5%)**			
6. Activating pre-knowledge on oneself through entry examination, participation in games/activities, and questioning. **(75.5%)**			
7. Exchanging ideas and improving mistakes through final examination, answering, and chatting on bulletin board. **(55.7%)**			

Domains	Confirmation (Percentage)	Disconfirmation (Percentage)	Reject (Percentage)
Principles (Cont.):			
8.Building bodies of knowledge through the steps of comprehension, memorization, analysis and application by using supplementary activities and doing exercises after the lessons. **(52.8%)**			
9. Creating creativity, reflective thinking and initiative idea by inventing a piece of work, summarizing and designing an invention. **(83.1%)**			
Teaching-learning environments:			
Components of teaching-learning management are Learners and Instructors**. (81.1%)**			
Teaching-learning/ activities strategies:			
1. Stimulating attention. **(77.4%)**			
2. Activating prior-knowledge.**(73.6%)**			
3. Informing the learners of expected outcomes.**(73.6%)**			
4. Manipulating stimulating conditions to gain attention. **(86.8%)**			
5. Providing learning guidelines. **(67.0%)**			
6. Searching for answers and exchanging knowledge. **(92.5%)**			
7. Reflecting, memorizing, analyzing and applying knowledge. **(77.4%)**			

Domains	Confirmation (Percentage)	Disconfirmation (Percentage)	Reject (Percentage)
8. Learning through Self Discovery. **(82.0%)**			
Teaching-learning models:			
1.The term 'dependent Learning' means that learning is designed by instructors.			
1.1 Drill-and-practices instruction. **(54.7%)**			
1.2 'Tests instruction' means a series of test items to help students enhance learning. **(73.6%)**			
1.3 'Games-based instruction' is an example of dependent learning. **(40.6%)**			
2.'Independent Learning' means learning is designed by students.			
2.1 Collaborative learning and/or Team-Based Learning. **(77.4%)**			
2.2 'Project-based learning' is an example of independent learning. **(75.5%)**			
2.3 'Group process learning' is an example of independent learning. **(71.7%)**			

Biography

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วิทยานิพนธ์ฉบับนี้เป็นงานวิจัยที่เกิดจากการค้นคว้าและวิจัย ขณะที่ข้าพเจ้าศึกษาอยู่ในคณะครุศาสตร์อุตสาหกรรม มหาวิทยาลัยเทคโนโลยีราชมงคลธัญบุรี ดังนั้น งานวิจัยในวิทยานิพนธ์ฉบับนี้ถือเป็นลิขสิทธิ์ของมหาวิทยาลัยเทคโนโลยีราชมงคลธัญบุรี และข้อความต่าง ๆ ในวิทยานิพนธ์ฉบับนี้ ข้าพเจ้าขอรับรองว่าไม่มีการคัดลอกหรือนำงานวิจัยของผู้อื่นมานำเสนอในชื่อของข้าพเจ้า

This thesis consists of research materials conducted at Faculty of Technical Education, Rajamangala University of Technology Thanyaburi and hence the copyright owner. I hereby certify that the thesis does not contain any forms of plagiarism.

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(Mr.BiQuan Mo)