THE DEVELOPMENT OF ACTIVITY-BASED LEARNING MODEL TO ENHANCE RESEARCH SKILLS FOR PRE-SERVICE TEACHERS OF INDUSTRIAL EDUCATION, FACULTY OF INDUSTRIAL EDUCATION AND TECHNOLOGY, KMUTT

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Abstract

This research aimed to 1) develop an activity-based learning model to enhance research skills for pre-service teachers of industrial education, Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi (KMUTT) and 2) study the effect of activity-based learning on research skills of pre-service teachers. The sample was divided into two groups; the first sample group was 29 pre-service teachers who were studying in the first semester of the 2015 academic year and the second sample group was 50 pre-service teachers who were studying in the first semester of the 2016 academic year in the Faculty of Industrial Education, KMUTT.

The results found that

1) The model of activity-based learning to enhance research skills of pre-service teachers was created from the integration of principles and research methodology including the practice of every step of research methodology. The learners learned how to gain research skills by "Practice of Doing Research". The teachers facilitated and mentored doing research under the concept of blended learning. The classroom activity focused on practicing research process as the goal weekly. A Facebook group was used for presenting instructional media, media for lecturing, examples of research, classroom learning activity, and for

being a center of communication and counseling outside the classroom. The content was classified into seven modules; (1) stating problems of research, (2) reviewing literature, (3) identifying research limitations, (4) research instruments, (5) research methodology, (6) data collection and analysis, and (7) research report. The learning management lasted 15 weeks long. Each module was composed of 5 steps; 1) knowing objectives, 2) learning principles, 3) practicing research, 4) presenting research, and 5) evaluating research, suggestion, and improvement (Formative Assessment). The research was evaluated by two experts to check the completeness and accuracy of the research (summative evaluation) after the 15th week.

2) The second group of samples had research skills significantly higher than the first sample group who were at the level of .05. The second group samples had research skills at the level of "very good" and the first group samples had research skills at the level of "good".

The samples reflected that they did not only gain knowledge and research skills but also had skill for searching for information, team-working skill and self-directed skill to achieve the goals and apply the knowledge for studying other courses such as project work.

Keywords: Activity-based learning; project-based learning; research skills; pre-service teachers of industrial education

Introduction

Country development for sustainable and balance needs human resource development for the global change in the 21st century due to the strength and powerful human resources in order to drive the country development process (The Office of Higher Education Commission, 2013; Office of the Permanent Secretary, Ministry of Education). So, the teachers play an important role to manage learning processes. The organization for providing teachers must develop the pre-service teachers to gain knowledge and research skills and use the research skills for professional development. As mentioned in National Education Act B.E. 2542 amended in B.E. 2545, Sections 24 and 30 state the pre-service teachers should be trained for thinking skills, management, confrontation and application knowledge for preventing students from problems, solving problems including atmosphere management for supporting learning processes for learners in any level of study (Office of the National Education Commission, 2002). The operational research helps for professional promotion of teachers and supports the pre-services teachers to learn as well (Ulvik, 2014). Moreover, the pre-services teachers have an opportunity to connect theoretical knowledge to practical application which can uncover the truth that is unclear from theory only through the practice and thereby gain explicit knowledge (Katsarou and Tsafos, 2013). The development of professional work of pre-service teachers and the ability to do operational research will lead to the learning accomplishment of learners (Banegas et al., 2013) and (Bleach, 2014). Operational research is one of the practical conversions not only from critical thinking but also comes from the basis of learning new things through the learning process and actual research practice to better understand and increase new important abilities and construct a body of knowledge (Gibbs, 2014). As mentioned, if the pre-service teachers know or gain research skills, this will change the teachers to be professional teachers and affect the learning methodology for learners.

Because of the importance of action research as mentioned, the organization producing teachers had provided the curriculum for teachers-who are studying to be teachers at the undergraduate level (5 years) since 2003. The field work experience of pre-service teachers was extended to one year and focused on teaching responsibility, action research, school curriculum development, learners' activity development, school service work, education and community service, and

other tasks assigned (The Office of Higher Education Commission, 2011). Faculty of Industrial Education, King Mongkut's University of Technology, Thonburi, is the organization to produce teachers in undergraduate study (5 years) get ready to prepare the pre-service teachers to do action research. The researcher is responsible for the course of educational research and found the problems of doing research of the pre-service teachers through their advisors. The pre-service teachers could not identify the topic for the action research and the research instrument used was problematic. In addition, there were problems with some teachers such as lack of knowledge in measurement and evaluation, especially in analytical thinking and advanced behaviors (Klaharn, 2018). Therefore, the preparation of research skills for the pre-service teachers should be done before the field work experience of pre-service teachers.

The study of the concept and the research found that the research skills could be developed by activity-based learning, blended learning, and project-based learning, and with the instructor acting as mentor or learning director. As the OHEC (The Office of Higher Education, 2008) mentioned, research skills had to be developed for the learners in many ways, both in theories and practices. Knowledge learning should be practiced by doing via direct experience. The research mentor should help and give advice for doing research and motivate the researcher. This was harmonized with the research in the past (Umawan 2008; Van der Westhuizen, 2008; Jumpasri, 2009; Tamiyakul, 2009; Chaowatthanakun, 2010; Jankhantee and Rodrangka, 2010; Jamjang, 2012; Katsarou and Tsafos, 2013; Sopakayung et al., 2013; Ulvik, 2014) and it was found that the development of research skills was composed of 1) delivering knowledge of research theoretically in terms of main idea/topic, 2) operational training on research methodology using activity-based learning and project-based learning, 3) supervising and following up the research practice or research mentoring by giving advice, sharing experience on classroom action research, and 4) support from administrators and staff.

As mentioned, the researcher intended to integrate the learning model using activity-based learning for developing research skills of industrial pre-service teachers by doing classroom action research with the instructor acting as a research mentor, expected the pre-service teachers to gain action research skills, measurement and evaluation knowledgeable in research, and confidently applied

for learning management for the students before the field work experience of pre-service teachers.

Reviewed Literature

1. Definition of Action Research

The synthetization of action research definition, action research means the process or the study of teachers to consider what happens in the classroom and make a decision to choose the best way for solving problems or enhancing the learning development for the best result (Mettetal, 2001; Faikamta, 2012; Vongvanich, 2012; Fandiño, 2010).

2. Research related to development of action research skills method

The research on development of action research skills found the action research should be done throughout the research process. The practice of action research helped the pre-service teachers gain knowledge and motivated the teachers to create the action research in advance as a part of the teacher role.

The research tried to practice action research for the pre-service teachers in the 8th semester of the five-year curriculum of education in Norway. The action research was done and reflected the learning activity from a professor. The learning activity focused on three approaches: 1) instructional method started by an introduction by motivating the learners through an appropriate method, 2) communication in the classroom with more discussion, and 3) good output by the learners daring to ask for advice and gain more motivation. The study found that pre-service teachers realized that the learning activity and research tools were useful for them, but some of pre-service teachers identified the research task as difficult and too big comparing with the five credits of the course (Ulvik, 2014). In Greece, the development of pre-service teachers was by doing action research as a role of teacher. The research started by searching for information to manage the learning process by doing lesson plans and taking the lesson plans to manage the learning process in practice to develop a long-term professional career. The steps of action research practice composed of 1) identifying the question for finding the answer from the context in the classroom, analyzing the problem of the educational situation and identifying a meaningful research project, 2) planning and doing the action research with the plan focusing on the learning activity of searching for information from a variety of learning resources to

stimulate the learners' imagination, and 3) evaluating from the reflection after the learning management and creating a familiarity of the reflection learning skill. The learning reflection used documents to reflect both successful and unsuccessful learning and asked these questions: What was successful and what was not successful in learning management? Why do you think you are successful in learning management? These questions were for discussion leading to better potential of learning management. The stage for research presentation was provided for the pre-service teachers to improve their next research and learning activity plan. The learning activity supported the students to participate in the learning design and gain knowledge for professional areas. The pre-service teachers were impressed by the research process which connected the theoretical to the practical. The process ensures that the pre-service teachers learn and get familiar with educational research and do practical research throughout the research process (Katsarou and Tsafos, 2013). In Norway, the development for teachers occurs by doing action research, identifying a framework of research and learning resources, sharing experience among teachers especially inviting the successful teachers to inspire the pre-service teachers to make use of action research as the tools for teachers' development in the future (Ulvik, 2014).

3. Related researches and method of action research skills development

From the study of the concept and related researches, the action research development should be focused on activity-based learning composed of blended learning, project-based learning and the instructor acting as a research mentor or learning director (Umawan, 2008; Van der Westhuizen, 2008; Jumpasri, 2009; Tamiyakul, 2009; Charoenmongkonvilai, 2011; Jankhantee and Rodrangka, 2010; Jamjang, 2012; Sopakayung et al., 2013; Katsarou and Tsafos, 2013). The process of dependent variable development was as follows.

3.1 Dependent variables of blended learning (Pharacheewa, 2007; Uratchanoprakorn, 2009; Siripipattanakoon, 2010; Charoenmongkonvilai, 2011; Samarak, 2013) were learning achievement, project work skill, project quality, problem-solving skill, and critical thinking skill.

3.2 Dependent variables of learning activity by project-based learning (Yannaboon, 2007; Hariharan, 2011; Wongdee et al., 2016; Sangragsa, et al., 2016; Niemi et al., 2015) were composed of research methodology knowledge, self-paced learning skill, knowledge searching for individual problem-solving, motivation, and life skills such as communication skill.

3.3 Dependent variables of learning activity that the instructor taking the action as a mentor and facilitator (Umawan, 2008; Tamiyakul, 2009; Jumpasri, 2009) consisted of research competency of public health personnel and teachers.

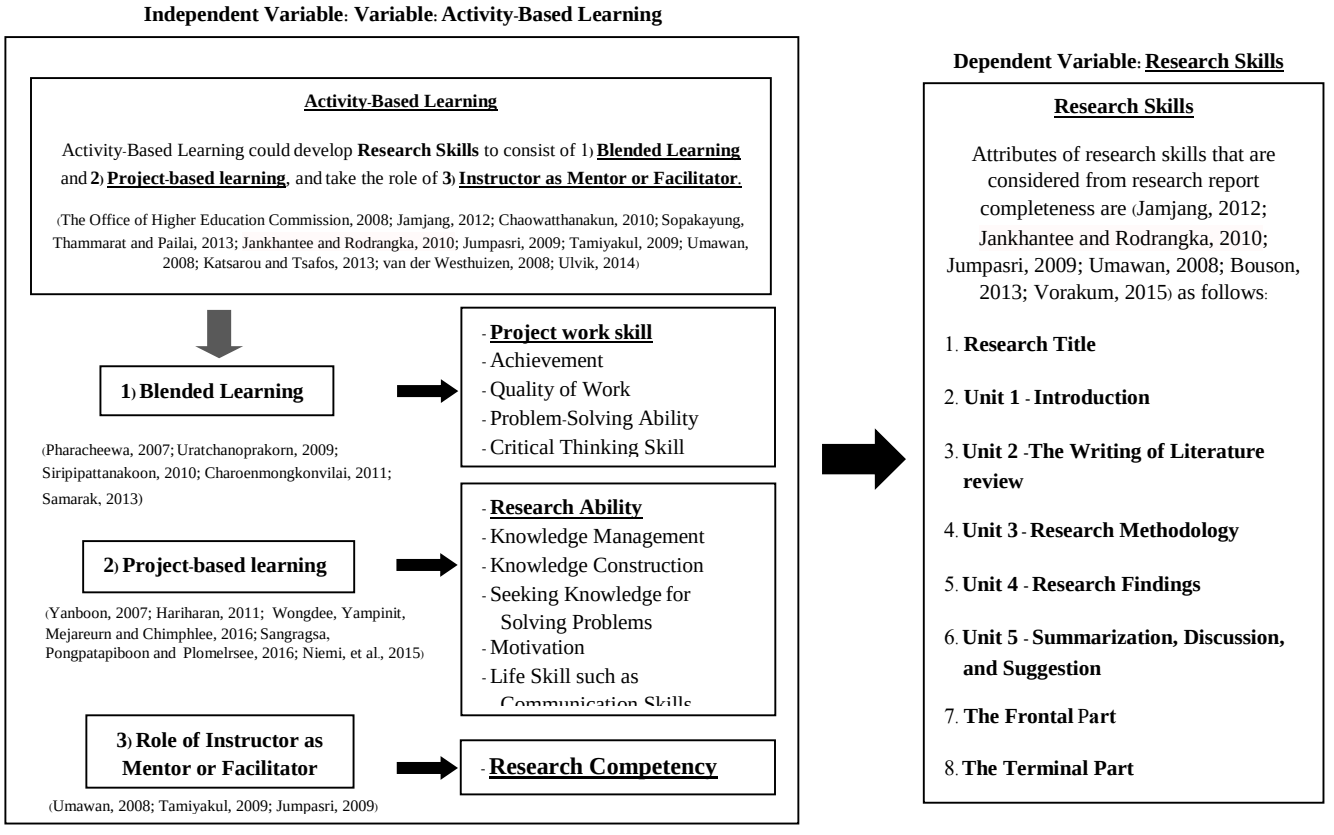
3.4 The component of classroom action research skills -The component of classroom action research skills for measurement of research skills by the researches (Umawan, 2008; Jumpasri, 2009; Jankhantee and Rodrangka, 2010; Jamjang, 2012) consisted of 1) Research Title (concise sentence with dependent and independent variables and context), 2) Unit 1 - Introduction (introduction and the statement of problems, research objectives according to the title, research hypothesis according to the research objectives, limitation of variables is complete and correct, and operating definition is complete and covered all variables), 3) Unit 2 - The writing of literature review (completely covered all variables, cited from a variety of credible resources and synthesized the main idea for creating the research instruments), 4) Unit 3 - Research Methodology (research instruments were validated and harmonized with the variables of the research objectives, and the statistics in data analysis were appropriate for the type of data), 5) Unit 4 - Research Findings (the research findings were complete and sequenced by objectives), 6) Unit 5 - Summarization, Discussion, and Suggestion (summarization of the research process was concise and complete, discussion was complete according to the research objectives, and the research suggestion was possible to apply in the future), 7) The frontal piece such as the abstract was from the research conclusion and was written concisely, and the acknowledgement was concise and complete, 8) the terminal piece such as Reference was complete according to the system, concisely and consistently written, and appendices were complete with correct information, and 9) Others such as correct and consistent Keywords were used, the arrangement of the research unit was correct, and fonts were complete, concise, and consistent.

Research Objectives

1. To develop an activity-based learning model to enhance research skills for pre-service teachers of industrial education, and

2. to study the effect of activity-based learning on research skills of pre-service teachers of Industrial Education, Faculty of Education and Technology, KMUTT.

Conceptual Framework



Research Hypothesis

1. The activity-based learning model to enhance research skills for pre-service teachers of industrial education used learning activity based tasks via classroom action research practice by integrating the concept and theories of learning by doing and the use of mentor or facilitator in terms of a blended learning approach.

2. The research skills of pre-service teachers of industrial education was at least at the level of "good".

Research Limitation

1. The samples were pre-service teachers. The first sample group was 29 pre-service teachers who were studying in the first semester of the 2015 academic year and the second sample group was 50 pre-service teachers who were studying in the first semester of the 2016 academic year.

2. Research Variables

2.1 Independent variables - The activity-based learning model to enhance research skills for pre-service teachers of industrial education was composed of the sub-learning model, activity-based learning, project-based learning, and the research mentor or learning facilitator.

2.2 Dependent variables - research skills of pre-service teachers of industrial education were composed of the nine components of research: 1) Research Title, 2) Unit 1 - Introduction, 3) Unit 2 - Writing the literature review, 4) Unit 3 - Research Methodology, 5) Unit 4 - Research Findings, 6) Unit 5 - Summarization, Discussion, and Suggestion, 7) The frontal part, 8) - the terminal part, and 9) Others.

Research Instruments

1. Lesson plan of activity-based learning model - The content was classified into seven modules, and the learning activities lasted 45 hours. The lesson plan was evaluated by experts on educational research and action research in terms of principles, objectives, activities, and evaluation. The experts' suggestions were used for improvement. The lesson plan was tried out in the first semester of the 2014 academic year with 38 pre-service students and improved.

After that, the lesson plan was studied in the experiment with two groups of samples. The first sample group was operated in the first semester of the 2015 academic year (January - May 2016) and the second sample group was operated in the first semester of the 2016 academic year (January - May 2017).

2. Evaluation test for research skills of pre-service teachers of industrial education - The evaluation test for research skills was a 5-point rating scale, and the description of the research skills was in noted in a rubric. The test was inspected by the experts and tried out. The description scoring of research skills was improved for easier scoring. The inter-rater reliability was done by the researcher and a two-professor team of a research course for pre-service teachers. The inter-rater reliability was at 0.80 which was according to the criteria at 0.70 (Craig and James, 2003) before using with the step of research skills test for samples.

Research Design

This research design was posttest only design (University of Minnesota, 2018) by the repetition of research on two groups of samples. To assure the effect of independent to dependent variable, the characteristics of the samples were similar - same department, senior level - and the samples were evaluated according to research skills by summarizing problem-solving in daily life. It was found that the samples had no different ability on alignment objective, learning experience and evaluation.

Statistics for Data Analysis

The evaluation of research skills was tested by two professors; one was the researcher and the other was a professor who was experienced in research skills evaluation. The statistics were as follows:

1. Percentage of research skills - from the student's research report according to the criteria.

2. Mean and standard deviation of research skills.

3. Comparison of research skills of both sample groups using Mann-Whitney U Test.

Research Results

1. The activity-based learning model (ABLM) to enhance research skills for pre-service teachers of industrial education was integrated by using theory, principles, and research methodology including the practical research method by the professor acting as a facilitator or mentor and using the blended learning approach and activities in ABLM to manage for the goal of research in each week. Facebook was used for group activity to discuss and summarize the content, instructional media research examples, learning activities in the classroom and learning reflections. It was also used as a communication center and asking for advice after class. The model was composed of the following.

1.1 The principle of ABLM - the model was focused on activity and doing research project in practice. The instructor facilitated student-friendly engagement by adding more channels for advice and communication and used it for submitting the learning materials through the Facebook group, composed of the sub-learning model, activity-based learning, project-based learning, and the research mentor or learning director, with details as follows:

1.1.1 Blended Learning - Integrated Learning Management Model used the Facebook group for communication and asking an instructor outside of class, and posted all learning materials for learning research via a Google Drive that organized folders into categories. Face-to-Face Learning was activity-based by providing practice through the classroom research project of a problem of vocational education students obtained from interviewing the vocational teachers.

1.1.2 Learning activities focused on classroom research activities (Project-based learning) - The instructor prepared weekly activities, and the training was based on core knowledge and examples followed by the order to apply knowledge in their own research group. Instructor played a facilitator role every week and completed all the skills of the research with pre-service teachers. They learnt theories by themselves on most of the topics. The instructor added completeness to their understanding when learners summarized concepts. There were some topics that were revised in the learning management in the second group such as the statistics in the data analysis that the instructor needed to educate and there were activities to check the understanding.

1.1.3 The instructor played a role as a mentor or learning facilitator with kindness to encourage students to believe in their abilities and dare to ask. Sometimes the instructor played the role of mentor for helping guide, reflected on the knowledge accuracy of student research, and provided a chance to improve by using formative assessment and more explaining to learners when the learner is unsure while performing.

1.2 The objectives of ABLM - To develop research skills of the students.

1.3 The content of the ABLM was classified into seven modules and each module was composed of five steps of learning activities: 1) perceived the goal of the weekly task: to understand the task in each week, 2) learned the principle: the principle of the task in each week. The students helped to search for information and present the synopsis of the group; the instruction helped to complete the task, 3) the action research was done in practice: the research was according to the research methodology, the important task was worked on together in the class, the less essential task was worked on outside the class with the instructor's or mentor's help; whereas the students did the research, 4) presented the result of the research to the instructor for checking, and 5) after formative assessment by the instructor, the students corrected their work according to the instructor's suggestions and improved the research.

1.4 The evaluation of the ABLM: 1) The instructor checked for correctness in research writing following principles of research, 2) the instructor had to check weekly students' task, evaluated the correctness according to the research methodology and provide feedback for three times; unit 1, unit 1-2 and research instruments, and unit 1-3 of the research and research instruments, and 3) the 4th submission was a complete research which was around the last of the semester for evaluating the research skills. The evaluation of research skills was according to correctness in research methodology.

The method of learning management and evaluation was shown in Table 1.

Table 1: Activity-Based Learning Model: ABLM

Module	Learning objectives/Learning result	Activity / Media
1. Identify the state of the problem (3 weeks)	1.1 Principle of action research: Describe the action research cycle (Plan – Act – Observe – Reflect)	1.1 Watched VDO of research, and questioning through the pictures, action research cycle, the students answered and the instructor summarized to complete.
	1.2 Identify the research title: Name the research with completeness of the composition, and identify the variables, both dependent and independent variables.	1.2.1 Studied the research examples to solve instructional problems. The students identified the composition in the research title. 1.2.2 Students studied individually, and identified problems from interviewing the pre-service teachers or the teachers. The problems included learning achievement of certificate students and skills of the 21st century. 1.2.3 Used the group process with 5-6 members to select a dependent variable in the 21st century skills and the content for designing learning management for naming action research. 1.2.4 The instructor advised to add more research names.
	1.3 Identify the research questions and objectives: write the research objectives related to research questions and sequence the research process.	1.3 Studied the research examples on research questioning and objectives. The instructor summarized the principle and composition of the research objectives; in the step of research writing practice, the instructor advised and gave more examples.

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
2. Review literature and related researches. (2 weeks)	2.1 Write rationale and the statement of problems (Introduction): search information for presentation. (1) goals/a policy to identify dependent variable (2) advantage of dependent variable (3) present status of Thai youth; dependent variable (low) and samples (4) new learning management for developing dependent variable from principle, theory and related researches (5) write references for information (6) write all of the references and correct pattern	2.1.1 Watched VDO of the research and identified the research questions as the principle of writing introduction and then the students answered the questions. The instructor checked the answers as the principle of writing introduction, scored the writing of introduction according to the VDO. 2.1.2 The instructor identified the issue to search for information on the topic of writing introduction. 2.1.3 The instructor checked the information searched and advised to get complete information. After that the students wrote the rationale and the statement of problem as the example in the drill with the principle of writing in each paragraph. The instructor advised further on writing with an example for better result.
	2.2 Improve the naming of the research title: 2.2.1 select one technique of the independent variable suited with the students' age and content.	2.2.1 Allowed the students to do individual work. All the students searched for the abstract of experimental researches that studied the same independent and dependent variable. Each groupwork of the students found more than one independent variable and one technique. After that, studied the learning management steps in each technique and analyzed for selecting appropriate independent

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
2. Review literature and related researches. (2 weeks)	2.2.2 review the research title after searching for information of related researches to complete the component and adapt the research questions and objectives to relate to the research title.	variable and studied the characteristics identifying the students had dependent variable to confirm the learning activity and evaluation tools. 2.2.2 The information searched for was used for reviewing the research title that related with objectives.
	2.3 Review related literature: 2.3.1 Identify the keyword from all variables, take the keywords to identify a sub-title to search for information to complete the content covering all variables. Realize the usefulness of information. (1) meaning for operating definition (2) characteristics of variables to create research instruments (3) steps of creation and development of instruments and quality of variables.	2.3.1 The students studied how to identify the topic for searching information, related literature and documents for teaching from the research examples. The students identified the research topic and submitted to the instructor and asked for suggestion. The instructor advised and gave examples by group. 2.3.2a The instructor demonstrated how to search information related to one sub-topic of literature and information arrangement, citation and writing references.

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
2. Review literature and related researches. (2 weeks)	2.3.2 Search for information according to the research topic and arrange correctly. Synthesize the information according to the references including using correct citation.	2.3.2b The students searched for the sub-topic in the research. It was the learning management (independent variable) and characteristics to identify the dependent variable. The instructors checked for the harmonization of content and the topic, arrangement, and references. 2.3.2c Summarized the main idea to connect the research application.
3. Specify the research limitation (2 weeks)	Specify the research limitation and all topics in the introduction: 3.1 Write the hypothesis from the reviewed literature and related researches. Write the research limitation.	3.1a Group activity – Each member of the group had a task for one topic; the principle of writing hypothesis, research limitation, expected benefit, and operating definition. 3.1b The members who got the same task helped each other to study the principle for the task and summarized the main idea, gave an example and presented. Each member wrote the knowledge learned for the group. Discussed, asked question and wrote the research report in the context of each group. 3.1c The instructor advised how to write a hypothesis to describe variables using the principle to design.

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
3. Specify the research limitation (2 weeks)	3.2 Expected benefits (beside the researcher and the samples, others also got benefit from the research).	3.2 The students analyzed the output and outcome from the research examples. Questioned the outcome of the research and asked who will get benefit from the research.
	3.3 Operating definition writing: Identify the keywords, all variables, and short words in variables. (The information searched from review literature enabled to define the definition of keywords).	3.3 Operating definition writing – studied the research examples and identified all variables.
4. Creation of research instruments (3 weeks)	4.1 Creation of research instruments: 4.1.1a Selection of the principle for designing learning activity. Apply the appropriate steps to develop learners or solve students' problem (innovation) for writing hypothesis. 4.1.1b Summarize the characteristics to identify the dependent variable and create the activity and instruments for variable evaluation.	4.1.1 The students took information of learning management steps and characteristics and identified the dependent variable and selected some characteristics to design the learning activity or learning management for the students to obtain the sub-dependent variable in the lesson plan (formative assessment). 4.1.2a The students took information summarization (steps of learning management that were selected) to create an instrument as research innovation.

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
4. Creation of research instruments (3 weeks)	4.1.2a Create innovation (independent variable) in learning management related to the synopsis's principle and identify in hypothesis as the description of learning management innovation. 4.1.2b The students design the learning activity development as the characteristics according to the dependent variable in learning activity of lesson plan and follow the steps of learning management searched. 4.1.3 Select the characteristics to identify the level of dependent variable of the learners. Create the instrument for evaluating dependent variable appropriately according to the principles and design the learning activity properly.	4.1.2b Searched for the steps of creation and quality evaluation of innovation. 4.1.3a Studied the characteristics that identified the dependent variable for evaluation instrument creation. Selected the characteristics to create the instrument for dependent variable assessment. Advised the students to use characteristics for learning activity and posttest. 4.1.3b Searched for the steps of evaluation instrument creation, quality evaluation and evaluation of the dependent variable. Additional instructional media such as example of lesson plan, instrument for evaluating dependent variable and process of making.
	4.2 Quality evaluation for research instrument: contact and qualify the quality evaluation form by the experts. The experts evaluate the instruments (validity) and improve the evaluation form as suggestions.	4.2 The students took the instrument for evaluating the quality by the experts, the instructors checked for understanding and summarized the steps of the process and evidences before the evaluation. In case the evaluation tools were learning activities, the criteria should be inspected and a rubric created to describe the description of activities.

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
5. Research methodology writing (1 week)	5. Research methodology writing: 1) Identify the population and samples, related to the introduction (lesson 1). 2) Present the steps of research methodology, create research instrument both the innovation and evaluation form of dependent variable from the principle of research instrument which was searched from researches and related literature (Lesson 2). 3) Present the steps of experiment and research framework related to the data of dependent variable. 4) Identify the statistics for instruments' quality and the scale for evaluation of dependent variable. Identify the statistics for data analysis and relate it to the hypothesis in terms of dependent variable.	5.1 All members of the group selected the task of research methodology. For the same task, the members worked together by studying the knowledge, principle examples, and presented the result of the study. The instructor summarized and completed the topic by connecting with lessons 1 and 2 of the research. 5.2 Summarized the principle correctly. 5.3 All members of the group were responsible for tasks (one task one person). 5.4 Submitted to the instructor for checking by group and gave suggestions.

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
6. Data collection and analysis (3 weeks)	6.1 Data collection: - Do learning management in 30 minutes and collect the data by the qualified instrument. - Record the data after teaching and evaluation and write down the learning record and suggestions for improvement.	6.1 The students managed the learning activity with their friends according to the lesson plan. Data was collected for dependent variable. To observe the learning management, the learning outcome should the focus in observation.
	6.2 Data analysis: 6.2a Identify the data measuring scale to use for questioning and identify the statistics for data analysis. 6.2b Analyze the data by using a computer program for data analysis and write the result of data analysis and translation.	6.2a Lectured on the content on statistics and examples, situation to answer on the scale of measuring and statistics for data analysis, and the data from many scales of measurement, and covered the instruments of learners. (The learners had low knowledge about research statistics.) 6.2b Trained the students to use a computer program of data analysis (through step-by-step instruction from the instructor and repetition of some instructions to get familiar) using case study (statistics for data analysis), manual of using computer program for data analysis, and form of data analysis presentation.

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
6. Data collection and analysis (3 weeks)	6.3 Presentation of data analysis: Adjust the statistics for data analysis and take the data for learning management according to the lesson plan, analyze the data and present translation of the data correctly.	6.3 The students checked for statistics from data analysis which was presented the previous week. Corrected and managed the learning process according to the lesson plan. Analyzed data as done last week. Presented the data analysis, translated where the instructor advised or was mentored by group and gave advice and examples for measuring data with similar or same scale.
7. Research report writing (2 weeks)	7.1 Complete research report writing: Identify the composition of the research and any lost topic of research such as (1) research limitation in introduction (lesson 1) (2) report of research instrument creation in lesson 3 (3) lesson 5; summarization, discussion and suggestion.	7.1 In all modules for learning management, the students were able to write the research report from lessons 1-4 and appendices. The instructor assigned the students to summarize the composition of complete research and consider completing the report.
	7.2 Discussion: The students write a complete discussion. Each item of discussion is composed of (1) raising up the outstanding research, (2) interpreting the evidence, giving reasons of the evidence, (3) taking information and ideas to confirm the result and citation.	7.2 The students practiced writing discussion form the action research. A case study was used in the class and the students wrote the discussion. The instructor answered, scored, suggested by group and gave some examples to apply for discussion writing.

Table 1: (Continued)

Module	Learning objectives/Learning result	Activity / Media
7. Research report writing (2 weeks)	7.3 Suggestion writing: The suggestion is to apply the research results related to the expected benefit and make it possible in practice and according to the research results. To apply for learning management, the learning management planning should be considered to gain the learning objectives. The suggestion for further research should be continued from the research with reasonable items such as studying the other dependent variables or changing the innovation by adding more media, time, or learning steps.	7.3 Learned from the example of suggestion writing from the main media and advised students with different examples.

Note: the main media for each week was composed of research examples, Power Point for lecturing, documents, and drills of action research (with principle, examples, and assignment for practice).

2. The result of research skills by group – From the research report of 15 weeks, it was found that most of the first sample group (77.78%) and all of the second sample group had research skills at the level of "good to very good". Most of the second sample group (90%) had research skills at "very good" level. The evaluation on research skills found that the research skills of the second sample group was significantly higher than the first sample group's at the level of .05. The second sample group had research skills at the "very good" level ($\bar{x}$ = 4.63, S.D. = 0.21), and the first sample group had research skills at the "good" level ($\bar{x}$ = 4.14, S.D.= 0.59).

When considering each aspect of the nine main aspects and one sub-aspect totalling 10 aspects, it was found that the second group had higher skill level than the first one at the .05 level of significance. The first group had a good level of skills in eight areas of writing, as follows:

1) Research title
2) Introduction and the statement of problems
3) Introduction
4) Literature Review
5) Research Methodology
6) Front
7) Ending
8) Others

In the writing, summarizing, discussing, and suggesting ideas, the second group had the same level of skill as the first group, but the second one had significantly higher scores than the first one, with a statistically significant level of .05.

The second group had a significantly lower skills score than the first group - .05 is the presentation of the research findings. The first group had very good skills, while the second group had good skills. There are several groups of research of pre-service teachers. The results of the research are presented in the form of different statistics depending on the measure of data measurement of skill variables. The statistics presented were complete but were not correlated with the statistical type in chapter 3 and the assumptions in chapter 1, which have been written before the creation of research tools. In addition, some research reports did not enter the symbol * in the case of statistical significance, according to the detail shown in Tables 2-3.

Moreover, the students reflected they had more skills of searching information, team working, and self-directed skills, which could enable them to apply for studying other courses such as project work. The first group reflected that after one year of learning and field work experience, the activity-based learning model to enhance research skills for pre-service teachers of industrial education was beneficial and made them more confident to do action research and suggested the instructor continue to use the activity-based learning model to the next generation of students.

Table 2: Score of Research skills of Pre-service Teachers Classified by Years 1 and 2

Percentage of the score	Level of research skills	Year 1		Year 2	
		n	%	n	%
60.00 – 74.99	Average	2	22.22	-	-
75.00- 84.99	Good	3	44.45	1	10.00
85.00-100.00	Very good	4	33.33	9	90.00
Total		**10**	**100.00**		**100.00**

Table 3: Mean and Standard Deviation of Pre-service Teachers' Research Skills after Studying via Activity-based Learning

Description	Sample group	Completeness of work			Z	Sig
		$\bar{X}$	S.D.	level		
1. Research Title	**1**	**4.11**	**.33**	**Good**	**-3.814***	**.000**
	2	**5.00**	**0.00**	**Very good**		
1.1 Clear and concise	1	4.11	.33	Good	-3.814*	.000
	2	5.00	0.00	Very good		
1.2 Clearly identified the variables, both dependent and independent variables, including context	1	4.11	.33	Good	-3.814*	.000
	2	5.00	0.00	Very good		
2. Unit 1 - Introduction	**1**	**4.18**	**.33**	**Good**	**-3.553***	**.000**
	2	**4.89**	**.14**	**Very good**		

Table 3: (Continued)

Description	Sample group	Completeness of work			Z	Sig
		$\bar{x}$	S.D.	level		
2.1 Wrote introduction and the statement of problems	1	4.03	.34	Good	-3.991*	.000
	2	5.00	0.00	Very good		
(2.1.1) Displayed the data that showed dependent variable development for learners such as policy, benefit of dependent variables, and cited the references.	1	4.89	.33	Very good	-1.054	.292
	2	5.00	0.00	Very good		
(2.1.2) Identified the problems (low level dependent variables) that occurred in overview, problems of samples, and references of the problems.	1	3.22	.83	Fair	-3.707*	.000
	2	5.00	0.00	Very good		
(2.1.3) Identified how to solve the problems and provided citation (from the principle and research)	1	4.00	.87	Good	-2.984*	.003
	2	5.00	0.00	Very good		
(2.1.4) Presented the data concisely, and summarized to show what to do and the advantages from the research.	1	4.00	.00	Good	-4.243*	.000
	2	5.00	0.00	Very good		
2.2 Wrote the research objectives according to the title and objectives.	1	4.89	.33	Very good	-1.054	.292
	2	5.00	0.00	Very good		
2.3 Wrote the research hypothesis according to the research objectives.	1	4.78	.67	Very good	-.860	.390
	2	4.60	.70	Very good		
2.4 Presented the research limitation and covered the research limitation.	1	4.78	.44	Very good	-.810	.418
	2	4.60	.52	Very good		
2.5 The limitation of variables was complete and correct.	1	4.89	.33	Very good	-.077	.939
	2	4.90	.32	Very good		

Table 3: (Continued)

Description	Sample group	Completeness of work			Z	Sig
		$\bar{X}$	S.D.	level		
2.6 Operating definition was complete. Covered all variables.	1	4.22	.83	Good	-2.643*	.008
	2	5.00	0.00	Very good		
2.7 The operating definition was written in the research context.	1	3.33	1.00	Fair	-4.023*	.000
	2	5.00	0.00	Very good		
2.8 The research process was defined from the literature review.	1	3.00	1.00	Fair	-3.664*	.000
	2	5.00	0.00	Very good		
3. Unit 2 The writing of literature review	**1**	**3.97**	**.55**	**Good**	**-2.842***	**.004**
	2	**4.69**	**.37**	**Very good**		
3.1 Literature review was complete and covered all variables.	1	3.78	.67	Good	-4.156*	.000
	2	5.00	0.00	Very good		
3.2 Data was cited from varieties of resources, and was adequate for innovation development and research instruments.	1	4.11	.33	Good	-3.347*	.001
	2	4.90	.32	Very good		
3.3 Data was credible; the citation was correct and provable in citation.	1	4.89	.33	Very good	-1.054	.292
	2	5.00	0.00	Very good		
3.4 Data presentation was according to the title and sub-title.	1	4.67	.50	Very good	-1.936	.053
	2	5.00	0.00	Very good		
3.5 The synthesis of main idea in any topic covered the research and lead to create the research instruments and research context.	1	4.67	.71	Very good	-.578	.563
	2	4.60	1.26	Very good		

Table 3: (Continued)

Description	Sample group	Completeness of work			Z	Sig
		$\bar{x}$	S.D.	level		
3.6 The literature review was related to the main variables.	1	4.00	1.50	Good	-1.477	.140
	2	4.60	1.26	Very good		
3.7 The synthesis and summarization of literature review was done for research benefits.	1	3.00	1.41	Fair	-1.513	.130
	2	3.90	1.45	Good		
3.8 The synthesis and summarization of literature review was done for research framework.	1	2.67	1.12	Fair	-3.212*	.001
	2	4.50	.71	Very good		
4. Unit 3 Research Methodology	**1**	**4.23**	**.58**	**Good**	**-1.958***	**.050**
	2	**4.59**	**.13**	**Very good**		
4.1 Topic, process of research methodology.	1	4.56	1.01	Very good	-1.532	.126
	2	5.00	0.00	Very good		
4.2 Identified the amount description of population, and references for population.	1	4.67	.71	Very good	-1.532	.126
	2	5.00	0.00	Very good		
4.3 Identified the amount, description of samples, selection of samples (sampling).	1	3.33	1.22	Fair	-2.826*	.005
	2	4.80	.63	Very good		
4.4 Identified the research instruments, research innovation, data collection tools.	1	4.78	.44	Very good	-1.534	.125
	2	5.00	0.00	Very good		
4.5 Research instruments were harmonized to the variables of the research objectives.	1	5.00	.00	Very good	-1.381	.167
	2	4.60	.84	Very good		
4.6 Presented the research instruments creation and the validation of research instruments.	1	3.22	1.20	Fair	-.347	.728
	2	3.20	1.03	Fair		

Table 3: (Continued)

Description	Sample group	Completeness of work			Z	Sig
		$\bar{X}$	S.D.	level		
4.7 The research treatment and data collection were complete and correct.	1	4.33	1.41	Good	-.772	.440
	2	4.80	.63	Very good		
4.8 Statistics in data analysis were appropriate for the type of data and research hypothesis. Presented the formula of statistics correctly.	1	4.00	1.22	Good	-.306	.760
	2	3.90	.88	Good		
4.9 The criteria for dependent variable efficiency were harmonized to the statistics used.	1	4.22	1.39	Good	-1.928	.054
	2	5.00	0.00	Very good		
5. Unit 4 Research Findings	**1**	**5.00**	**.00**	**Very good**	**-3.338***	**.001**
	2	**4.30**	**.42**	**Good**		
5.1 The research findings were complete, and sequenced by objectives.	1	5.00	.00	Very good	0.000	1.000
	2	5.00	0.00	Very good		
5.2 Data analysis was complete and directly related to the data collection.	1	5.00	.00	Very good	-3.338*	.001
	2	3.60	.84	Good		
6. Unit 5 Summarization, Discussion, and Suggestion	**1**	**3.57**	**.45**	**Good**	**-2.057***	**.040**
	2	**3.89**	**.62**	**Good**		
6.1 Summarization of research process was concise and complete.	1	4.44	.73	Good	-2.297*	.022
	2	5.00	0.00	Very good		
6.2 Summarization was according to the research objectives.	1	4.56	.53	Very good	0.000	1.000
	2	4.40	.97	good		
6.3 The research discussion was complete according to the research objectives.	1	4.67	.50	Very good	-.573	.567
	2	4.40	.84	Good		

Table 3: (Continued)

Description	Sample group	Completeness of work			Z	Sig
		$\bar{X}$	S.D.	level		
6.4 The research discussion was correct according to the principles (presentation of the research findings / rational interpretation / according to the other researches).	1	3.67	1.00	Good	-2.179*	.029
	2	4.50	1.27	Very good		
6.5 The research presentation was outstanding in any issue, and the interpretation was rationally done.	1	4.44	.73	Good	-1.136	.256
	2	3.70	1.42	Good		
6.6 The research presentation was outstanding in any issue, and the interpretation was rationally done.	1	3.11	.93	Fair	-1.690	.091
	2	3.90	1.45	Good		
6.7 Suggestion was presented for research application.	1	2.89	.78	Fair	-3.649*	.000
	2	4.80	.63	Very good		
6.8 The research suggestion was impossible to apply in the future.	1	2.33	.87	Must be improved	-2.986*	.003
	2	4.00	1.05	Good		
6.9 Suggestion for future research was reasonable, comprehensible, and practical.	1	2.00	.50	Must be improved	-2.995*	.003
	2	4.00	1.41	Good		
7. The frontal	**1**	**3.92**	**.41**	**Good**	**-3.310***	**.001**
	2	**4.63**	**.29**	**Very good**		
7.1 The abstract was from the research conclusion.	1	3.89	.33	Good	-2.481*	.013
	2	4.60	.84	Very good		
7.2 The abstract was written concisely.	1	3.78	.83	Good	-.131	.895
	2	3.90	.88	Good		
7.3 Preface and acknowledgement were appropriate.	1	4.00	.00	Good	-4.243*	.000
	2	5.00	0.00	Very good		

Table 3: (Continued)

Description	Sample group	Completeness of work			Z	Sig
		$\bar{X}$	S.D.	level		
7.4 The content was concise.	1	4.00	1.22	Good	-3.008*	.003
	2	5.00	0.00	Very good		
8. The terminal	**1**	**4.41**	**.64**	**Good**	**-.597**	**.550**
	2	**4.63**	**.40**	**Very good**		
8.1 References were complete according to the system.	1	4.89	.33	Very good	0.000	1.000
	2	4.80	.63	Very good		
8.2 References were concisely written and consistent.	1	4.33	1.00	Good	-.182	.856
	2	4.30	.95	Good		
8.3 Appendices were complete with correct information.	1	4.00	1.12	Good	-1.986*	.047
	2	4.80	.63	Very good		
9. Others	**1**	**3.89**	**.60**	**Good**	**-2.642***	**.008**
	2	**4.57**	**.35**	**Very good**		
9.1 Keywords were correct and consistent.	1	4.00	.50	Good	-3.752*	.000
	2	5.00	0.00	Very good		
9.2 The arrangement of the research unit was correct.	1	3.89	1.05	Good	-1.889	.059
	2	4.70	.48	Very good		
9.3 The typing principle and fonts were complete, concise, and consistent.	1	3.78	.44	Good	-.847	.397
	2	4.00	1.05	Good		
Overview	**1**	**4.05**	**.30**	**Good**	**-3.351***	**.001**
	2	**4.63**	**.21**	**Very good**		

* $p<0.05$

Discussion

The research results were able to be discussed in two issues as follows:

1. The activity-based learning model to enhance research skills for pre-service teachers of industrial education was developed by integrating the learning principles, theory and educational research methodology and the research practice. The instructor was both a facilitator and a mentor using the blended learning approach. The process of the activities in project-based learning model to enhance research skills for pre-service teachers of industrial education in any module was composed of five steps as follows:

Step 1 Goal perception - Each member of the research group perceived the objectives and goals of action research. The group planned together and responded to the task to understand the principle of the task. This step was to apply the idea and principle to work in a team which was harmonized to Strnadová, et al. (2014) who mentioned that the researcher needed to know the assigned task for goal accomplishment.

Step 2 Learn the principle - The students had to know the principle theory and research methodology according to the research goals in Step 1. This step focused on the samples and the students had to know the principle of each task before doing action research in practice. This was harmonized to the research of Van der Westhuizen (2008) who divided the learning management on the principle of research methodology for the students. The learning activity focused on knowing research methodology, being a professional teacher, and doing action research for pre-service teachers.

Step 3 Research practice - The students applied knowledge weekly to do group research in practice in groups. The research questions were identified by the members of the group. This step created experience for the students. The task was very difficult for the students because of the application of many scientific knowledges. After 15 weeks of research practice, the students reflected that they learned and realized the research principle and connected the lesson learned systematically. The research practice took time to reflect the idea and the instructor had to summarize the principle of the research task. The instructor got benefit from the activity-based learning in terms of understanding the theme of the course. This was harmonized to Wongdee et al., (2016) and Sangragsa

et al., (2016) also found the learning management with "Learning by Doing" concept affected the pre-service teachers gaining research skills. This was harmonized to Niemi et al., (2015) who found that the learning achievement through practice could stimulate the learners to understand more the content from the classroom.

Step 4 Present the research in practice, and Step 5 Evaluate perceptions, suggestion, and improvement - In these steps, the instructor gave positive suggestions for research motivation. The students were to adjust the old version of doing research. These steps took time and seemed to be an evaluation of the students' research ability. This step was to present the research record as a formative evaluation and was harmonized to Hanover Research (2014) that mentioned the reflection of research practice affected the accomplishment of the research methodology according to the criteria, and to the research of Sangragsa et al. (2016) which was an EDU-WESTERN Model composed of learning activity through practical learning activity including the coaching process. This affected the pre-service teacher who converted routine work to classroom action research and gained research skills at a high level. Moreover, Mastan and Teo (2017) found motivational feedback was able to develop learning achievement in an English course also.

2. The evaluation on the complete research of the pre-service teachers or the sample found that the research skills of the samples were at the level of "good" to "very good" according to the hypothesis. This was caused by the enhancement to do research with a team in actual practice continually (week by week), and the task was adjusted weekly. Moreover, the researcher weekly evaluated and suggested completeness of the research. The score of the research report was high level. The sample reflected that they learned the research methodology and the learning process was beneficial for the professionalism of teachers. The students said, "I gained the principle for doing research, searching information, and the research methodology", "I learned to do research step by step, many thanks", "Thank you. I will apply the knowledge in doing my project work", "I've got advantage from doing research. I'll apply in my project. It was perfect!", "I got benefit from this course, and it'll be applied in my daily life", "There were many advantages for other courses, I learned to work step by step", and "I have learned to do research more". The reflections of the students were harmonized to The

Office of Education Council which mentioned that for learning management by real experience or in practice, the instructor should provide the learning atmosphere for the students to learn happily, and the students should have opportunity to discuss and respond individually and in group. The students can learn from the practice and knowledge sharing among groups and instructor for the learning transfer (The Office of Education Council, 2007).

Conclusion

The activity-based learning model to enhance research skills for pre-service teachers of industrial education focused on "Practical Research Project" until the students went through all the processes. The instructor acted as a facilitator or mentor for activities in project-based learning and used the blended learning approach. The classroom activities focused on practicing the research methodology weekly. Facebook was used for learning presentation, instructional media, research examples, learning activity in the classroom, data presentation of learning activity in each week and the center for communication and asking for advice outside the class. The learning outcome was checked continually week by week. Suggestion and discussion or formative evaluation was done continually. This caused the students to obtain research skills at the levels of "good" to "very good". The samples reflected that they did not only gain knowledge and research skills but also had information searching skills, team-working skills, and self-directed skills to achieve the goals and could apply knowledge for studying other courses such as project work confided that they could be able to top up the knowledge in other courses such as project work before graduation. However, the students should have basic knowledge of research methodology such as design innovative lesson plans, learning management, development of learning activity and advanced thinking skills including development of dependent variable assessment tools in a course of Educational Evaluation, and basic statistics. This helped the pre-service teachers to design learning activity and cooperate with the instructor in industrial fields to inspect the lesson plan, learning achievement test, advance thinking evaluation in industrial course, and gain experience in research instrument and quality evaluation of the instrument and cooperate with the instructor in industrial fields to inspect the lesson plan, learning achievement test,

advance thinking evaluation in industrial course, and gain experience in research instrument and quality evaluation of the instrument. So, think about the items (starting with verbs and nouns) following the "to" in your sentence.

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