

Using Research Based Learning in Statistics Course to Develop the Students' Research Skills and 21st Century Skills

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Abstract—Using research based learning in the course of Multivariate Analysis for Education to develop the students' research skills and 21st century skills was conducted with nine fourth year Information Technology and Educational Evaluation students who enrolled the course as an alternative subject in the first semester of academic year 2014 at the Faculty of Education, Prince of Songkla University Pattani campus. The course composed of the sections of theories, practice and research project methodology in the parallel form. The subjects were evaluated by the mid-term test, the final test, the task skills, the research skills, and the 21st century skills. The findings revealed that the mean of the research skills and the 21st century skills assessed by the students themselves and the instructors was above 70%. In addition, the relationship between the research skills and the 21st century skills was the highest correlation and they were also related to the task skills.

Index Terms—active learning, teaching statistics, research skills, 21st century skills

I. INTRODUCTION

The University of Melbourne-based and Cisco-, Intel-, and Microsoft-funded Assessment and Teaching of 21st Century Skills (AT21CS) consortium defines and divides 21st century skills and knowledge including attitudes, values, and ethics into four categories. The first one is Ways of Thinking involved with creativity and innovation, critical thinking, problem solving, decision making, and learning to learn (or metacognition). The second type is Ways of Working involved with communication and teamwork. Then, the third category is Tools for Working involved with general knowledge and Information Communication Technology (ICT) literacy, and the last one is Living in the World involved with citizenship, life and career, and personal and social responsibility, including cultural awareness and competence [1]. Developing learners for 21st century skills and knowledge is rather complicated and difficult to achieve the aims. Thus, instructors must try to design learning which is suitable for learners in order to make

them competent and skillful as needed. The instructors might find some ways or innovations to support the learning and be consistent with the course, the target learners as well as the process of learning management.

Accordingly, instructors or teachers play an important role in developing learners to have 21st century skills and knowledge. Teachers have to change a role of teaching while learners should also learn how to learn. In other words, students need to learn from their schema or by doing, namely Child-Centered or Learner-Centered. It corresponds to the Constructivism focusing on learners' process of knowledge construction. Learning styles in the 21st century can be as follows: 1) Begin with the whole - expanding to parts 2) Pursuit of student questions and interests 3) Primary Sources from manipulative materials 4) Learning is interaction - building on what students already know 5) Instructor interacts and negotiates with students 6) Assessment via student works, observations, points of view, tests. Process is as important as product 7) Knowledge is dynamic and change with experiences and 8) Students work in groups Learning [2]. It implies that teaching technique in the 21st century should be integrated learning. Teachers should encourage learners to apply knowledge and principles to learning activities in classroom so that learners are actively engaged in a learning process. It can be said that the 21st century learning is learning through learners' own schema.

One of the most important quantitative subjects in a university curriculum is Statistics. It has an impact on the development of life-long perception and attitude towards the value of statistics for several learners, and hence future employees, employers and decision makers. Statistics learning management in nowadays does not only involve the principles, discussion of definitions or formulas, calculating presentation, but also engages learners in using a statistical package to analyze data or a term project with oral presentations, and critiques of statistical ideas or issues in the news in order to draw students' ability to evaluate and utilize statistical knowledge [3], [4]. On the other hand, active learning and introducing activities where students are also able to construct knowledge, that is students work together to solve problems and share ideas and understanding. The collaborative group works with computers and data sets.

The students are engaged in data collection, reflection on and exploration of statistical concepts, and solving problems on their own [5], [6]. Additionally, they are encouraged to explain terminology and to interpret the statistical results in everyday words in order to develop the skill of communicating statistics [7], [8]. For the role of instructors, they emphasize the use of statistics in everyday life and give examples of incorrect analyses and statistical illiteracy from the media and reports for developing statistical literacy and critical thinking skills of the learners [9].

Rosenshine [10] presented ten principles of instruction that all teachers should know. Teachers should 1) begin a lesson with a short review of previous learning, 2) present new material in small steps with student practice after each step, 3) ask a large number of questions and check the response of all students, 4) provide models, 5) guide student practice, 6) check for student understanding, 7) obtain a high success rate, 8) provide scaffolds for difficult practice, 9) require and monitor independent practice, and 10) engage students in weekly and monthly review. The learning process of the principle 8-10 is complicated in order to follow the learning objectives as planned. These are consistent with developing research skills which compose of many steps: research problem, review literature, research purposes, research hypotheses, research design (sampling design, measurement design, and analysis design), data collection, data analysis and data interpretation, conclusion, and reporting research findings. The research skills have to be systematically and continuously developed. According to Kardash [11], the research skills assessment of the undergraduate students was differentiated by the gender in some aspects. The study of Gilmore and Feldon [12] revealed that the teaching and research skills assessment through self-report of the undergraduate students and one of the postgraduate students were not significantly different. desJardins [13] developed the research skills of the Computer Science undergraduate students by doing the mini-research project.

Research based learning is a process of instruction in which learners are centered. In order to response the aims of instruction; a research can be a part of learning process. The research based learning encourages learners to ask a question, raise an issue, analyze a current problem and find a solution. It aims to engage learners in learning process from their own experience rather than lessons in a traditional classroom. This makes the learners know how to seek knowledge continuously and become knowledgeable. Healey [14] and Elsen, Visser-Wijnveen, Van Der Rijst, and Van Driel [15] applied the research based learning in four main styles which are 1) develop the knowledge and understanding of the theories from researches, 2) develop the task skills from research outcomes, 3) develop research basic skills, and 4) develop research skills by proposing a research title. Many studies reveal that the research based learning can raise the academic achievement of the learners. For example, Viphatphumprathes [16] used the technique of

research based learning to search research articles or thesis for presentation and discussion in the course of ASEAN Community. Junpeng [17] also applied the technique of research based learning to improve the research skills by doing research in the course of Educational Research Methodology whereas Kijitrawutiwong and Saetan [18] developed the research skills by doing research in the course of Public Health Research. At the same time, Sitkuntod [19] developed the research skills by doing research in the course of Business Research. Moreover, Myatt [20] let students practice so that they could learn and be more skillful than the passive learning. Lopatto [21] and Robert and Blacker [22] found that except knowledge and research skills, there are relevant skills particularly the problem solving skill occurred. The findings of several studies on research based learning show a higher performance or learning process [23]-[28].

From the concept and the process of learning management, it is interesting to apply the research based learning in the course of Multivariate Analysis for Education to develop the students' research skills and the 21st century skills in three aspects which are ways of thinking, ways of working, and tools for working. The findings of this study can be a guideline leading to a higher academic achievement and life skills of the learners.

II. METHODS

A. Setting

This study was to apply the research based learning to the learning management of Advanced Statistics Course. The subjects were the undergraduate students who passed the courses of Introduction to Statistics, Statistical Application in Educational Research, Statistical Design in Education Research, Educational Research Methodology, and Action Classroom Research. The subjects were taught the theories by explaining their principles, concepts, and how to use the statistical package in order to motivate them to become curious and interested to seek knowledge and answer a question. In the same way, many research articles were raised for the discussion. The subjects were suggested to read research papers by focusing on presenting the main point of the research papers and relating to what they were learning. In the practice section, the subjects were encouraged to analyze data by using the statistical package, explain and present the results, and find a research article to criticize and discuss together. For the part of criticizing, the main point was to find a conclusion of the articles in many issues which relate to their research such as research problem, research objectives, research methodology, conclusion, and recommendations. When finishing the lessons, the subjects took the mid-term and final exam, and their task skills were also evaluated.

The target group consisted of nine fourth year students in Information Technology and Educational Evaluation program at the Faculty of Education, Prince of Songkla University Pattani campus who attended the course of

Multivariate Analysis for Education in the first academic year of 2014. The course contained the lessons of multiple regression, multivariate analysis of variance, factor analysis, discriminant analysis, and canonical correlation analysis. It took 15 weeks or 60 classes: 30 for the theoretical section and another 30 for the practice one. The research session lasted four months starting from August 13rd - December 30th, 2014.

B. Activity Description

This learning activity divided the students into groups of three. They had to present research problems, review literature, design research instruments, collect data, conclude the findings and write a research article with 10-15 pages. The learning management of the theories, practice and research project were parallel. The process of research project would begin in the third week of learning and extend the period of practice by two months. After finishing the course, the students had to write their research article. At the end of research project, the students' research skills and the 21st century skills were evaluated. The way of learning management is presented in Table I.

TABLE I. SCHEDULE OF LEARNING MANAGEMENT IN THE SECTION OF THEORIES, TASKS AND RESEARCH PROJECT PROCESS

Week	Lecture and laboratory	Research project
Week1-2	multiple regression	-
Week3-4	multivariate analysis of variance	research problem
Week5-6	factor analysis	review literature
Week7		research purposes and research hypotheses
Week8	midterm test	
Week9-10	discriminant analysis	research design (sampling design, measurement design, and analysis design)
Week11-12		data collection
Week13-14	canonical correlation analysis	data analysis and data interpretation
Week15		conclusion and reporting the finding
Week16	final test	

C. Measures

The task skills, research skills, and 21st century skills as well as the mid-term and final exam were evaluated by the following research instruments.

1) Lesson plan of five learning units includes the evaluation form of the task skills in each unit with a total of 20 points.

2) Subjective mid-term and final test includes the content, the discussion of results from the statistical package and the criticism from research papers with a total of 40 points.

3) Research skill evaluation form includes two sections with a total of 20 points. In the first section, there is a self-assessment questionnaire with five-Likert scales: Excellent, Very Good, Good, Moderate, and Poor. Another section is the questionnaire of performance evaluated by the instructor with three levels of rubric scoring: Good, Moderate, and Poor. The questions are

about "What" relating to research problem, "How" relating to research purposes and research hypotheses, review literature, research design (sampling design, measurement design, and analysis design, and "Conducting to the study" relating to data collection, data analysis and data interpretation, conclusion and reporting the finding [17]. There are 16 question items with a total score of 20.

4) Evaluation form of the 21st century skills including ways of thinking, ways of working, and tools for working is divided into two parts with a total of 20 points. The first section is self-assessment with five-Likert scales ranking from "Always", "Often", "Sometimes", "Rarely", and "Very Rarely or Never". Another section is the questionnaire of performance evaluated by the instructor with three levels of rubric scoring ranking from "Good", "Moderate", and "Poor". A total item is 12, the samples of question items are as follows:

- I think reasonably and use many ways to solve a problem.
- I pose an important question clarifying the issue and leading to the better solution.
- I understand some limits from your friend in the group in order to accept my new point.
- I can communicate in different ways both verbally like speaking, writing and non-verbally like gesture, facial expression.

Mean and standard deviation were employed to show the central value and the distribution value of the mid-term test, the final test, the task skills, the research skills, and the 21st century skills. Pearson Correlation Coefficient was also employed to show the relationship between the scores or the skills.

III. RESULTS

The results of using the research based learning in the course of Multivariate Analysis for Education with 15 weeks were from the mid-term test, the final test, the task skills, the research skills, and the 21st century skills as shown in Fig. 1 and Table II.

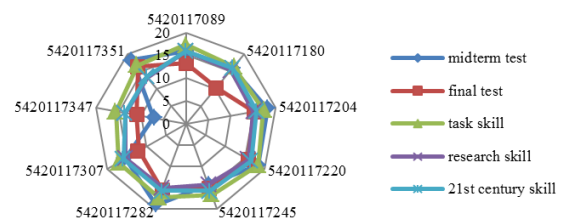


Figure 1. The scores of the mid-term test, the final test, the task skills, the research skills and the 21st century skills from all 9 students

From Fig. 1, it clearly shows that most of the students got the same scores of the mid-term test, the final test, the task skills, the research skills and the 21st century skills. Only three out of nine students (student ID: 5420117180 5420117307 and 5420117347) had the different scores from the central value of the mid-term test scores and the final test scores.

As presented in Table II, the mean scores on the mid-term test, the final test and the task skills were 15.87

13.81 and 16.96 out of 20 respectively. The average scores of the research skills self-assessment of the students were 3.29 out of 5. For the research skills assessment through students' performance, the students scored differently in the three aspects: "what", "how", and "conducting of the study". To illustrate, the average percentage of "conducting of the study" was the highest which was equal to 83.4. Secondly, the average percentage of "how" was equal to 75.6. The average percentage of "what" was the lowest which was equal to 72.4. The mean scores of the 21st century skill self-assessment of the students were 3.82 out of 5. For the 21st century skill assessment through the students' performance, it was found that tools for working contained the highest scores which were 4.17 followed by ways of working 3.78 and ways of thinking 3.61 respectively.

TABLE II. DESCRIPTIVE STATISTICS OF THE MID-TERM TEST SCORES, THE FINAL TEST SCORES, THE TASK SKILL SCORES, THE RESEARCH SKILL SCORES AND THE 21ST CENTURY SKILL SCORES

	Full score	Mean	S.D.	Min	Max
1. Midterm test	20	15.87	3.66	7.14	19.14
2. Final test	20	13.81	2.22	10.33	16.33
3. Task skills	20	16.96	.75	15.67	18.33
4. Research skills					
What	2	1.44	.17	1.20	1.60
How	5	3.78	.44	3.00	4.00
Conducting of the study	8	6.67	.40	6.40	7.20
Self-assessment	5	3.29	.50	2.31	4.00
5. 21 st century skills					
Way of thinking	5	3.61	.42	3.00	4.00
Way of working	5	3.78	.44	3.00	4.00
Tools for working	5	4.17	.25	4.00	4.50
Self-assessment	5	3.82	.32	3.36	4.50
Total	100	76.87	6.94	60.96	84.67

The analysis of the relationships between the mid-term test scores, the final test scores, the task skills, the research skills and the 21st century skills is shown in Table III.

TABLE III. PEARSON CORRELATION COEFFICIENT BETWEEN THE MID-TERM TEST SCORES, THE FINAL TEST SCORES, THE TASK SKILL SCORES, THE RESEARCH SKILL SCORES AND THE 21ST CENTURY SKILL SCORES

	Midterm test	Final test	Task skills	Research skills	21 st century skills
Midterm test	-				
Final test	.651	-			
Task skills	.745*	.612	-		
Research skills	.456	.024	.675*	-	
21 st century skills	.408	-.099	.683*	.919**	-

* $p < .05$, ** $p < .01$

From Table III, it was found that the research skills were positively and significantly correlated with the 21st century skills ($r = .919$, $p < .01$). Secondly, the mid-term

test scores were positively and significantly correlated with the task skills ($r = .745$, $p < .05$). The task skills were also positively and significantly correlated with the 21st century skills ($r = .683$, $p < .05$). Moreover, the task skills were positively and significantly correlated with the research skills ($r = .675$, $p < .05$). For other correlations, there was not any significant relationship.

Some findings from developing the research skills in the class of Multivariate Analysis for Education became three interesting research articles presented in the 25th national academic conference under "Thai research: A vision of futurity" on June 10-12, 2015 at Thaksin University, Songkh as Fig. 2. The proceeding titles are as follows:

1. Factor influencing decision-making to study of higher education in ASEAN and Arab countries of student at the three southern border domicile provinces.

2. Canonical correlation between satisfaction of safety and convenience of checkpoints set up in the three southern border provinces.

3. Factor influencing decision-making to shop online of students at Prince of Songkla University, Pattani campus.



Figure 2. Presentation of the proceedings in the 25th national academic conference "Thai research: A vision of futurity" at Thaksin University

For the suggestions, the students thought that using the research based learning promoted them to seek and understand additional knowledge except the lessons. The examples presented in the classroom motivated their learning and encouraged them to synthesize the real research. Then, they learned how to write the explanation under the table of data analysis and saw strong or weak points of each research paper. At the same time, criticizing the research papers and doing the research for writing a paper let them see the consistency of the research process starting from a research problem to a conclusion and a discussion. It was different from learning or doing a research with five chapters which made them hard to link up the main points clearly. Lastly, presenting their research findings among the graduate students and the professors at the academic conference made them proud of themselves and experienced the academic atmosphere; very few undergraduate students had this chance.

IV. DISCUSSION

To conclude, the research based learning improved the research skills and the 21st century skills as can be seen

from the average scores which was above 70 percent in the students' self-assessment and the evaluation by the instructor. In addition, the value of correlation between the research skills and the 21st century skills was the highest. These two skills were also significant related to the task skills in each learning unit. It implies that the higher task skills the students have, the higher their research skills and their 21st century skills are. In other words, if the students have high research skills, they will have high 21st century skills. Furthermore, the students could present their own research in the academic conference which achieves the aim of the 21st century skill. The findings correspond to the ways of learning in the 21st century involving a group process and constructivist learning [2]. The findings of this study are also in line with ten principles of learning management, namely to provide scaffolds for difficult practice as well as to engage students in weekly and monthly review [10].

Besides, the findings are consistent with several studies. For instance, the study of Viphatphumiprathes [16] involves with using the research based learning as a tool to search research articles or thesis for presentation and discussion in the class of ASEAN Community. It reveals that the academic achievement from research based learning was higher than that from traditional learning. The study of Junpeng [17] involves with the research based learning to improve the research skill by doing research in the class of Educational Research Methodology for the fourth year students at KhonKaen University. The research skill and knowledge increased to 75 % and 70% of the total scores respectively. Kijtirawutiwong and Saetan [18] developed the research skills by doing research in the Public Health Research Course for the fourth year students at Naresuan University. The difference of performance between pre- and post-research based learning management was significant. Moreover, Sitkuntod [19] revealed the development of research skills by doing research in the course of Business Research for the fourth year students at Sripatum University. Their average learning achievement was above the criteria. They got a better decision-making skill and more systematic working plan. Doing the research made the students understand the research methodology well. However, the main obstacle towards learning was that the period of time for doing research and working in group was not sufficient. This corresponds to the study of Ion, Lucu, and Palacio-Vieira [27] conducting the research based learning to the PhD and Master's students in Romania. It was found that the students had good attitude and feedback towards this kind of learning more than expected as well as the study of Huet, Mourtos, Costa, Pacheco, and Tavares [24] conducted with the university students in Portugal.

In short, conducting the research based learning in teaching, seeking knowledge and developing research skills made the instructor tend to focus on the tasks or the real practice more than the contents of the lessons. It let the students have the skills as expected by the instructor. Regarding the concept of Healey [14] and Elsen, Visser-Wijnveen, Van Der Rijst, and Van Driel [15], conducting

the fourth model of research based learning, developing the research skills by proposing a research title, was not only in a research course but also in the statistics course which includes many difficult theories, and practices. This is in line with the research of Prince, Borrego, Henderson, Cutler, and Froyd [26] and Huet, Mourtos, Costa, Pacheco, and Tavares [24] successfully conducting the research based learning in the engineering course. Nevertheless, the instructor might have to work harder and understand the research process in each step in order to draw and develop the students' research skills perfectly. For doing research and composing research articles, it was noticeable that the students were not good at writing the background, the significance of the problem and the discussion because of the lack of experience.

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