TuijinJishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 6 (2023)

Development of Ability to Create Mathematical Learning Activities through Competency-Based Learning for Preservice Teachers

Yupadee Panarach[1]

[1] *Mathematics Department, Faculty of Education, UdonThaniRajabhat University, Thailand*

Abstract:-This research integrated teaching and learning into research and academic service. The objectives were to study the ability to create mathematical learning activities and self-directed learning through competency-based learning for preservice teachers, as well as studying the results of organizing mathematical learning activities with basic education students by using action research. The results found that preservice teachers had the ability to create mathematical learning activities through competency-based learning at a high level. Considering each aspect, the research results showed that creative teamwork had the highest average, then the organizing learning activities, and learning design, respectively. They had a high level of self-directed learning after organizing competency-based learning activities, when considering each aspect found that the positive orientation to the future had the highest average, then the openness to learning opportunity, and love of learning, respectively. For the students, they had learning outcomes in mathematics at the highest level of 57.78 percent, a high level of 36.67 percent, and a moderate level of 5.56 percent, respectively, and attitude towards mathematics after participating in mathematical learning activities overall a high level.

Keywords*: competency-based learning, the ability to create mathematical learning activities, self-directed learning.*

1. Introduction

The National Education Plan (20172036-) has established principles for organizing education that each person had the capacity to work for occupations according to their aptitudes and interests. It was characteristics and learning skills for the 21st century and preparing the workforce in terms of the necessary knowledge, skills, and competencies to be able to adapt and be equally aware of the trends of change in a dynamic world. Therefore, it was urgently important that the government and all relevant sectors set the direction and goals for production and development of manpower in various fields, that was consistent with the national framework and professional standards, that promote teaching and learning and internships, it focused on complete, hands-on practice in real situations, such as producing and developing teachers with quality and standards [5]. The Teachers' Council of Thailand was an agency responsible for setting policies and professional development plans for teachers, who set standards for teachers' professional knowledge and experience that were consistent in their learning management competencies by integrating knowledge from learning course content and practice in simulation situations and application in real situations. Characteristics were consistent with the principles of competency-based learning management and emphasizes the practice. It contained a set of content, knowledge, skills, attitudes, and characteristics that were necessary to lead to the desired competencies at a level that learners can perform. It was a teaching method that integrates knowledge in many subjects related to real world jobs to success in work [13] and the study of [12] and [9], regarding the competencies of learning management in the 21st century of preservice teacher. These competencies consisted of learning design, student-centered

learning activities, develop the skills for the students in the new era, and measurement and evaluation of learning outcomes.

Developing competency in learning management required that students participated in every process, planning (Plan: P), implementation (Act: A), measurement and evaluation (Observe: O), including reflection on practice results (Reflect: R), which is an action research model based on the concept of Kurt Lewin, whereby the implementation process requires cooperation from all parties involved in solving problems [6]. Lewin's process aims to create the change by specifying conditions for practice the problem solving and it made people aware of creating alternatives or opportunities to get new and better things, it was a lively organic process [15]. Finding more solutions to solve problems or develop their work and emphasize the integration between theoretical concept and actual practice in the way of working and living in daily life, including being able to regularly check and reflect on your own work performance to solve problems that arises [4]. This process helped teachers develop themselves in academics [7]. It was learning that emphasizes on allowing students to be self-learning practitioners with goals. Through use of various learning processes to reach the specified goal and it started with an interest in knowledge combined with discipline and responsibility by leading yourself to meaningful learning, learning to seek knowledge for yourself without end, leading to the creation of a lifelong learning culture. It was an important and necessary culture for self-development in the present era, called self-directed learning [16], which people used the benefits from learning better and a long time than learning from teachers [3].

The importance of developing competencies in learning management for preservice teachers are the principles of competency-based learning management that emphasizes teaching and learning that integrates knowledge in many subjects that relates to real world job operations and applies that knowledge for success. The concept of action research allows preservice teachers to participate in planning and designing learning, organize learning activities, measuring and evaluating learning outcomes and reflect on learning results. Preservice teachers will have the ability to organize mathematics learning activities, self-directed learning occurs. The results of organizing mathematical learning activities showed the development of students' mathematical abilities and attitudes towards mathematics, that will develop important competencies and characteristics for preservice teachers that can apply to their future work.

2. Objectives

1. To study the ability to create mathematical learning activities through competency-based learning of preservice teachers.
2. To study self-directed learning through competency - based learning of preservice teachers.
3. To study the results of organizing mathematical learning activities with basic education students.

3. Methodology

A. Participants

The participants divided into twogroups were:

1. Preservice teachers in mathematics program, Faculty of Education, UdonThaniRajabhat University. There were 58 students in the third year of first semester in academic year 2022 who were co-designing in two set of mathematical learning activities. In Set 1 there 28 preservice teachers and in Set 2 there were 30 preservice teachers. Set 1 involved learning activities that promoted the ability of mathematical analytical thinking and Set 2 involved learning activities that promoted the ability of mathematical problem-solving.
2. The students in Bandondua school, Udonthani province. There were 90 studentsconsisting of 46 students in Grade 4-6 who received Set 1: Learning activity to promote ability of mathematical analytical thinking, and 44 students in Grade 7-9 who received Set 2: Learning activity to promote the ability of mathematical problem-solving.

B. Research Instruments

The instruments including:

1. The questionnaire about the ability to create mathematical learning activities has five components consist of learning design, preparing learning activities, organizing learning activities, measuring and evaluating learning outcomes, and creative teamwork totaling 43 items. The quality of validity analyzed by index of item – objective congruence (IOC) was between 0.67 to 1.00, and reliability analyzed by Conbach's Alpha overall was 0.94 and each aspect was between 0.81 to 0.90.
2. The questionnaire aboutself-directed learninghas eight components consist of openness to learning opportunities, self-concept as an effective learner, independent in learning, informed acceptance of responsibility for one's own learning, love of learning, creativity, positive orientation to the future, and ability to used basic study skills and problem-solving skills [2] totaling 36 items. The quality of validity analyzed by index of item – objective congruence (IOC) was between 0.67 to 1.00, and reliability analyzed by Conbach's Alpha overall was 0.95 and each aspect was between 0.73 to 0.85.
3. The mathematical learning assessment consist of:

   3.1 The mathematical analytical thinking test was nine subjective items. The quality of validity analyzed by index of item – objective congruence (IOC) was between 0.67 to 1.00, and reliability analyzed by Conbach's alpha was 0.80, difficulty value)p(between 0.22 to 0.77, and discrimination value)r(between 0.20 to 0.70.

   3.2 The mathematical problem-solving test was seven subjective items. The quality of validity analyzed by index of item – objective congruence (IOC) was between 0.67 to 1.00, and reliability analyzed by Conbach's alpha was 0.77, difficulty value)p(between 0.66 to 0.75, and discrimination value)r(between 0.20 to 0.27.

   3.3 The questionnaire about attitude towards mathematics was 13 items. The quality of validity analyzed by index of item – objective congruence (IOC) was between 0.67 to 1.00 from two groups. the reliability analyzed by Conbach's alpha was 0.84 for Grade 4-6, and 0.85 for Grade 7-9.

C. Data collection

Competency-based learning management is a process that focuses on allowing preservice teachers to study and summarize knowledge to apply in real situations. Applying the concept of action research with the concept of qualitative management as shown in Figure 1. which was four steps as follows:

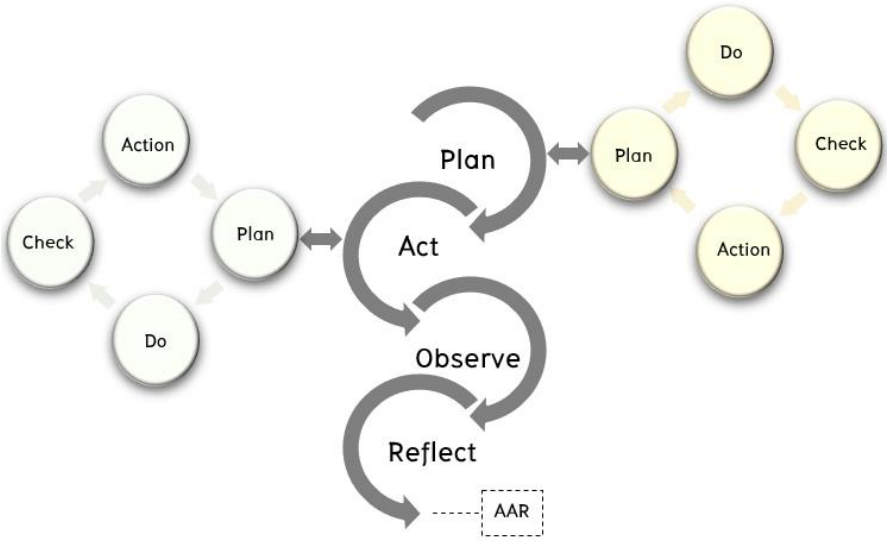

Fig. I competency-based learning process

Step 1: Planning (Plan: P)to prepare preservice teachers had ability to learning design, preparing learning activities in mathematics. The proceed were:

1.1) Plan (P) study, summarize, and present ideas for designing learning activities and student learning results, and exchange of knowledge in the classroom.

1.2) Do (D) design and prepare learning activity plans with media, equipment, and evaluation tools. The learning activities divided into two sets:

Set 1: Learning activity to promote ability of mathematical analytical thinking consisted of 5 steps as questioning, seeking of information, creation of knowledge, learning to communicate, and dissemination of knowledge.

Set 2: Learning activity to promote the ability of mathematical problem-solving consisted of 4 steps as understanding the problem, problem-solving planning, implementation of the plan, and inspection.

1.3) Check (C) organize learning activities in simulation situations with friends in the classroom to examine the process of organizing learning activities.

1.4) Action (A) improve organizing learning activities in each activity by the group which was the operator, the students, and the observer.

Step 2: Practice (Act: A) preservice teachers apply mathematical learning activities to the target group of students, evaluate and improve the activities. The proceed were:

2.1) Plan (P) preservice teachers organize academic service projects and request permission to take them outside of the university. Coordinate with schools that are the target group.

2.2) Do (D) organize learning activities by dividing students into 2 groups:

Grade 4-6 students receive Set 1: Learning activity to promote ability of mathematical analytical thinking.

Grade 7-9 organize Set 2: Learning activity to promote the ability of mathematical problem-solving

Each group organizes 8 learning base activities.

2.3) Check (C) the target took the mathematical learning assessment. Grade 4-6 received Set 1: Learning activity to promote the ability of mathematical analytical thinking. Grade 7-9 received Set 2: Learning activity to promote the ability of mathematical problem-solving. Both groups took questionnaires on attitudes towards mathematics.

2.4) Action (A) improve organizing learning activities and learning outcome of students in each activity.

Step 3: Observation (Observe: O) preservice teachers took the questionnaire about the ability to mathematical learning activities and self-directed learning.

Step 4: Reflection (Reflect: R) preservice teachers reflect on the results of organizing mathematical learning activities, reflect on issues that should be further improved, issues that should remain, and issues that need further improvement.

D. Data Analysis

1. Study of the ability to create mathematical learning activities through competency-based learning of preservice teachers was analyzed by mean and standard deviation.
2. Study of self-directed learning through competency-based learning of preservice teachers was analyzed by mean and standard deviation.
3. Study the results of organizing mathematical learning activities with basic education students consisted of the ability of mathematical analytical thinking, and the ability of mathematical problem-solving analyzed by frequency and percentage. Attitude towards mathematics was analyzed by mean and standard deviation.

4. Results

1. Preservice teachers had the ability to create mathematical learning activities through competency-based learning at a high level, when considering each aspect found that creative teamwork had the highest average, then the organizing mathematical learning activities, and mathematical learning design, respectively.

The results were presented in Table I.

Table I Mean and standard deviation (S.D.) of the ability to mathematical learning activities through competency-based learning of preservice teachers.

The ability to mathematical learning activities	Mean	S.D.	Meaning
.1Mathematical learning design.	4.00	0.72	high
2. Prepare mathematical learning activities.	3.98	0.68	high
.3Organizing mathematical learning activities.	4.14	0.72	high
.4Measuring and evaluating learning outcomes.	3.86	0.77	high
.5Creative teamwork.	4.45	0.71	high
Total	4.11	0.75	high

2. Preservice teachers had self-directed learning after organizing competency-based learning at a high level, when considered in each aspect found that the positive orientation to the future had the highest average, then the openness to learning opportunity, and love of learning, respectively.

The results were presented in Table II.

Table II Mean and standard deviation (S.D.) of self-directed learning through competency-based learning of preservice teachers.

Self-directed learning	Mean	S.D.	Meaning
.1Openness to learning opportunities.	4.25	0.74	high
2. Self-concept as an effective learner.	3.90	0.85	high
3. Independent in learning.	4.07	0.76	high
4. Informed acceptance of responsibility for one's own learning.	3.98	0.90	high
5. Love of learning.	4.09	0.72	high
6. Creativity.	3.89	0.71	high
7. Positive orientation to the future.	4.32	0.68	high
8. Ability to used basic study skills and problem-solving skills.	3.83	0.70	high
Total	4.02	0.78	high

3. The results of organizing mathematical learning activities found that the students had learning outcomes in mathematics at the highest level of 57.78 percent, a high level of 36.67 percent, and a moderate level of 5.56 percent respectively. The results were presented in Table III. They had a more positive attitude towards mathematics after participating in mathematical learning activities overall a high level. When considering

each aspect, it was found that mathematics can be used in everyday life had the highest average, then mathematics is a subject that helps to be reasonable, and students check the correctness of mathematics exercises, respectively.

The results were presented in Table IV.

Table III. Frequency and percentage of organizing mathematical learning activities with basic education students.

Level	Score	Mathematicalanalytical thinking(Grade 4-6)		Mathematical problem-solving (Grade 7-9)		Total	
		f	%	f	%	f	%
Moderate	60 – 69	–	–	5	11.36	5	5.56
High	70 – 79	12	26.09	21	47.73	33	36.67
Highest	80 – 100	34	73.91	18	40.91	52	57.78
Total		46	100.00	44	100.00	90	100.00

Table IV.Mean and standard deviation (S.D.) of attitude towards mathematics after participating in mathematical learning activities.

Attitude towards mathematics	Grade 4-6		Grade 7-9		Total		Meaning
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
1. Students feel that learning mathematics is fun.	4.18	0.78	3.59	0.99	3.89	0.89	high
2. Students love to study mathematics.	3.58	0.93	3.53	0.91	3.56	0.92	high
3. Students love to solve problems related to mathematics.	3.65	0.89	3.57	0.94	3.61	0.92	high
4. Students do mathematics exercises by themselves.	3.60	1.01	4.30	0.95	3.95	0.98	high
5. Students check the correctness of mathematics exercises.	3.77	1.13	4.22	0.96	4.00	1.05	high
6. Students answer teacher’s questions during mathematics class.	3.76	0.99	4.03	1.04	3.90	1.02	high
7. Students can explain the content or mathematics exercisesto their friends.	3.59	1.00	3.70	0.90	3.65	0.95	high
8. Students learn more about mathematics.	3.75	1.03	4.11	0.81	3.93	0.92	high
9. Students participate in mathematics-related activities.	3.90	1.13	3.59	0.85	3.75	0.99	high
10. Mathematics is a useful subject.	4.15	0.94	3.63	0.93	3.89	0.94	high
11. Mathematics is a subject that helps to think systematically.	4.28	0.82	3.57	0.94	3.93	0.88	high
12. Mathematics is a subject that helps to be reasonable.	3.89	1.01	4.30	1.02	4.10	1.02	high
13. Mathematics can be used in everyday life.	4.30	0.88	4.22	0.99	4.26	0.94	high
Total	3.88	0.96	3.87	0.94	3.88	0.95	high

5. Discussions

1. Preservice teachers had the ability to create mathematical learning activities through competency-based learning at a high level. The highest average was creative teamwork, the organizing learning activities, and learning design, respectively. That was a result of the competency-based learning process that applies the concept of action research together with the concept of qualitative management that emphasized having students work together in every step, from preparation, operation, inspection, and improvement work. This includes the consideration of the effects on students and reflection on the overall results of learning activities. Consistent with [12] which said that the principles of competency-based learning focus on practice. It contains a set of content, knowledge, skills, attitudes, and characteristics that are necessary to lead to desired competencies at a level that learners can perform. It is a teaching method that has integrated knowledge in various subjects related to the performance of a particular job to be used until success in operations.
2. Preservice teachers had self-directed learning after organizing competency-based learning that was at a high level. The highest average was the positive orientation to the future, the openness to learning opportunity, and love of learning, respectively. This result is due to the students' hands-on practice at every step in the process of competency-based learning. They get involved in the learning process [2]. Consistent with [3], [10], [16] who said that learning emphasizes allowing students to set goals, plan, follow the plan, and evaluate activities using a variety of learning processes. They will commit and strive towards the goals set by the learner both individually and as a member of a group. It is the development of self-directed learning.
3. The results of organizing mathematical learning activities found that the students had learning outcomes in mathematics at the highest percent in highest level, and they had more positive attitude towards mathematics after participating in mathematical learning activities overall. This result is due to designing learning activities with clear processes that emphasize practice with goals and use a variety of learning materials and equipment. Especially organizing learning activities outside of class to make students have fun with activities. This result is consistent with the research of [11], [8], [14], [1], and [17] – [18] found that organizing activity-based learning helps students have the ability to think analytically, problem solve, and have a good attitude towards mathematics.

Results from reflecting on the results of organizing mathematics learning activities found that there is still a need to improve regarding their work preparation, starting from the allocation of time for work, research, summary, and presentation of work activity. Then they design and plan to implementing activities throughout the system and organize activities in real situations. It gives real and useful experience that should continue to be given.

6. Conclusion

Ability to create mathematics learning activities helps to develop preservice teachers to be able to integrate knowledge into learning design, prepare learning activities, organize learning activities, measurement and evaluation of mathematics learning activities, and create teamwork which is an important competency in the teaching profession with using the principles of competency-based learning management that emphasizes allowing students to study, acquire knowledge, summarize knowledge and apply knowledge in real situations by applying the concept of action research together with the concept of qualitative management. This process also results in self-directed learning for preservice teachers, it is a learning process in which learners are free to plan their own studies and be responsible for implementing the plan, including measuring and evaluating one's own learning outcomes. The teacher stimulates and guides the students to make self-confidence for learning skills effectively. The development process also reflects the group of students who participated in the activities to develop mathematical ability and attitude towards mathematics.

References

[1] K. Kongarun and N. Phuengkuson, "Development of Math Camp Activities to Enhance Learners' Key Competency for Junior High School", Academic Journal of Phetchaburi Rajabhat University, vol. 12, no. 2, pp. 30-38, May-August 2022.
[2] L. M. Guglielmino, "Development of the Self-Directed Learning Readiness Scale", Dissertation, Ed.D. University of Georgia, Retrieved October 23, 2008, from UMI Proquest Digital Dissertations. 1977.
[3] M. S. Knowles, "Self-Directed Learning: A guild for Learner and Teacher", Chicago: Association Press, 1975.
[4] O. Naiyapat, "Research design: quantitative, qualitative and mixed methods", 2nd, Bangkok: Chulalongkorn University Press, 2011.
[5] Office of the National Economic and Social Development Board, Office of the Prime Minister, "National Economic and Social Development Plan, Issue twelfth 2017-2021, https://www.nesdc.go.th/ ewt_dl_link. php?nid=6422, 2016.
[6] P. Ketsang, "Action Research", Bangkok: Chulalongkorn University Press, 2016.
[7] P. Nuengchalerm, "Operations on action research in teaching and learning", KhonKaen: Kung Na-Na Wittaya, 2018.
[8] P. Taengkaew and et al., "Math Camp activity to promote analytical thinking skills for grade 4 to grade 6," Proceeding of The 1st National Conference on Education, Faculty of Education, KamphaengPhetRajabhat University, Thailand, pp. 717-728, March 29, 2018.
[9] R. Phromsa-ard, S. Meechain, and O. Charoensuk, "A Development of Indicators for Learning Management Competencies of Pre-Service Teachers in Faculty of Education at Phuket Rajabhat University", Journal of Educational Measurement Mahasarakham University,vol. 24, no. ,1pp. 268-255, July 2018.
[10] R. W. Skager, "Lifelong Education and Evaluation Practice", Hamburg: UNESCO Institute for Education.
[11] S. Udomsuk and et al., "Math Camp activities to promote mathematical problem solving skills for grade 4 to 6 students", Proceeding of The 1st National Conference on Education, Faculty of Education, KamphaengPhetRajabhat University, Thailand, pp. 808-818, March 29, 2018.
[12] T. Parnichparinchai, "The study fo the competencies of learning management for 21th century of bachelor degree student in education project for the development teachers in the wilderness at the Thai-Myanmar border area, Tak province, Faculty of education Naresuan university, vol. 19, no. 4, pp.123-132, 2017.
[13] Teachers Council Secretariat, Teachers Council, "Announcement of the Teachers Council Committee on Details of the standards of knowledge and professional experience of teachers according to the Teachers Council regulations Concerning professional standards (No. 4) 2019", https://www.ksp.or.th/ksp2018/ 2020/06/19628/, June 2020.
[14] U. Pantachord, "Establishment of mathematical analysis skill by utilizing self-directed learning for students in Ang Thong Phattana school", Phikul Journal, vol. 18, no. 1,pp.181-163 , January-June 2020.
[15] W. Suthinarakorn, "Action Research: Research for Freedom and Creation", Bangkok: Siam Publishing House, 2013.
[16] W. Wongyai and M. Phatthaphon. Creative self-directed learning. Bangkok: Innovative Leaders Center in Curriculum & Learning (LCCL), 2021.
[17] Y. Panarach, "Promoting Analytical Thinking ability in Mathematics by using Activity-based learning", The abstract book of the 7 and et al., Rajabhat University National and International Research and Academic Conference, SakonNakhonRajabhat University, Thailand, p.46, November 14-16, 2023.
[18] Y. Panarach, "Academic camp to promote the ability of mathematical problem-solving", The abstract book of the 7th Rajabhat University National and International Research and Academic Conference, SakonNakhonRajabhat University, Thailand, p.47, November 14-16, 2023.