SEAT

The Professional Learning Community for Teachers' Professional Development Training in Classroom Action Research for Enhancing Students' Science, Mathematics and Technology Competencies in New Normal

Panwilai Dokmai[1*], Wanicha Sakorn[2] and Ramnaree Nontapa[3]
[1]*Master Science Education Program, Rajabhat Maha Sarakham University, Thailand*
[2]*Master Computer Education Program, Rajabhat Maha Sarakham University, Thailand*
[3]*Master Mathematics Education Program, Rajabhat Maha Sarakham University, Thailand*
*Email: panwilai.ch@rmu.ac.th

Abstract. The purposes of this research were to: 1) conduct teachers' professional development training in classroom action research for enhancing students' science, mathematics, and technology competencies in new normal, 2) study competency-based learning management framework and 3) study competency assessment framework. The target group was 40 teachers including 14 science teachers, 13 mathematics teachers and 13 technology teachers from Maha Sarakham Province, Roi-et Province and Kalasin Province. The research tools were the teacher needs survey questionnaire and the PLC record forms. The data analysis was done by using descriptive statistics and content analysis. The findings revealed that the target group teachers have developed ability in classroom action research, competency-based learning management and competency assessment through the teachers' professional development training. The target group teachers could develop the competency-based learning management in new normal. These included 4 learning models in science, 1 learning models in mathematics and 4 learning models in technology. They shared common in the competency assessment in new normal on using activity sheet, worksheet, practice, and competency assessment inventory. There were two types of competency assessment tools including rubrics score and rating scale.

INTRODUCTION

The 21st century learning emphasized on scaffolding skills to support students to become literate and master both content and professionals. The students need deep understanding and participation with others for problem solving in both school and real-life situation. They also need to be creative and innovative to become the 21st century world citizen and be able to lead Thailand to go forward with the other country. The question is "How to potential students to help them possess the necessary competencies for the 21st century world?". The Thai ministry of education revised the national curriculum learning standards and indicators in science, mathematics, and technology in 2017, intended to conduct students in applying learning knowledge and experience for technology invention and benefits of the individual and society (The Ministry of Education, 2017). These being the case, the teachers responsible to integrate the 21st century skills into the subject lessons. They hence require teaching strategies and tools in classroom practice. The teachers have to adjust their teaching according to students' competency to solve real-life problem rather than problem on the tests. The problems which cannot solve by rote learning, on the other hand, call for competency and ability to confront to solve complex and unfamiliar problems in real-world settings. There are three science competency performances: explain phenomena scientifically, evaluate and design scientific inquiry, interpret data and evidence scientifically. The four mathematics competency performances are formulating, employing, interpreting and mathematical reasoning. And the five technology competency performances are ICA 1 (accessing, evaluating, and managing information and data), ICA 2 (sharing information and communicating), ICA 3 (transforming and creating information and digital content), ICA 4 (problem-solving in a digital context and computational thinking) and ICA 5 (appropriate use of ICT (online security, safety and risk awareness and skills) (IPST, 2022).

Competency-based education require students the skills to apply rather than memorize information that they could forget after completion of the courses. These requirements counted as students' competency which refers to a description of a particular mental ability or skill students are expected to learn (Gilmer, et al., 2011). Therefore competency-based learning management need to be differed from traditional teaching methods in both learning activity and assessment. The competency learning activity should be concerned that students tend to find some individual skills or competencies more difficult than others and allowed them to move at varying paces within a course (Gervais, 2016). As well as the competency assessment require to identify specific learning outcomes in terms of behavior and performance, including the appropriate criterion level to be used in evaluating achievement (Lattuca, et al., 2011).

The competency-based education is not an only new challenge for science, mathematics and technology teachers. The instruction during the COVID-19 pandemic is also a big impact for the teachers. The COVID-19 has created the largest disruption of education systems. The social distancing and restrictive movement policies have significantly disturbed traditional educational practices. The Thai ministry of education recommended 5 teaching models which the teachers could adopt for their class: 1) onsite teaching at school in the green areas, 2) on air learning at home through distance learning television (DLTV), 3) online teaching through the school recommended online platforms, 4) on demand learning through the share applications of the teacher and students and 5) on hands which the teacher prepare a programmed instruction for students' self-study at home with sometime visit of the teacher. However, these teaching models do not harmony with the competency-based education which need deep inquiry and highly participation in problem solving. The teachers therefore sought for a balance in these challenges and called them "the teaching in new normal"

While the teachers figure out how to deal with the competency-based education in new normal, national education act also drives them to engage research into their professional development. The Thai national education act B.E. 2542, Section 30 stated that "An establishment of education … shall promote an instructor to be capable of conducting research for a development of learning suitably for the learner in each level of education" (National Education Commission Office, 1999). The classroom action research seems to be the key for the teachers this time. The teachers could employ classroom action research in parallel with their competency-based teaching practice. Classroom action research is mentioned as an effective solution for teacher development in contexts (Bissonnette and Caprino, 2014). It could be used as a tool to find out strategy to solve problem in the classroom (Mettetal, 2002). The classroom action research will indicate the teachers what works best in their own classroom or what could improve student learning. The benefits of classroom action research have been stated in several studies in supporting professional development (Capobianco and Joyal, 2008), helping teachers develop their intellectual capacities and provoking awareness of how to create a context that supported change (Balach and Szymanski, 2003), increasing teachers' levels of self-efficacy and feelings of empowerment (Farrell, 2003) and also making professional relationships with their colleagues and students (Capobianco and Joyal, 2008).

The classroom action research has been reported on the growth of the group as a professional learning community (Balach and Szymanski, 2003). Recently, the use of classroom action research and the professional learning community (PLC) concept to support teacher teaching experience is accepted as contributing factors for the improvement of teaching practices (Johannesson, 2020; Sagor, 2010).. The PLC is a group of teachers sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented, growth promoting way (Stoll and Louis, 2007). This based on the desire for individual and community improvement and is enabled by the mutual respect and trustworthiness of the professional learning team (Hord, 1997). The professional learning team (PLT) include 1) model teacher who want to improved teaching performance and increase student achievement, 2) buddy teacher who's there for helping and supporting the model teacher, 3) administrator who provides supportive conditions for professional learning community and supervision the process through the professional learning community, 4) mentor who could closely mentor until the model teacher succeed e.g. head of the department or skillful teacher in the department/school and 5) expert who is a professional in the area of the issue practice of professional learning community e.g. university lecturer, educational supervisor, guru, etc. There are quite clear that the academically successful professional learning communities are require a shared vision that is developed from an unswerving commitment on the part of PLT team to students' learning and that is consistently articulated and referenced for their work, a collective learning among the team and application of the learning to solutions that address students' needs, the visitation and review of each teacher's classroom behavior by PLT team as a feedback and assistance activity to support individual and community improvement as well as physical conditions and human capacities that support such an operation (Hord, 1997). The literatures have been reported on the success of professional learning community on driving higher achieving students and performance teachers to school (Louis, 2006; Wilson, 2016; Brown, Horn and King, 2018). Moreover, the professional learning community is mentioned as safety place where the teachers could openness to new ideas, suspension of judgments, and commitment to inquiry exist can true reflection and dialogue occur between them (Sergiovanni, 1994).

The teachers in Maha Sarakham Province, Roi-et Province and Kalasin Province are concern and want to get ready for the competency-based curriculum that will be launch in their school very soon. The professional learning community classroom action research

could be a scaffolder for them to go through the new curriculum and the new normal of teaching and learning.

RESEARCH OBJECTIVES

There were four research objectives addressed in this study.

1) Conduct teachers' professional development training in classroom action research for enhancing students' science, mathematics and technology competencies in new normal.

2) Study competency-based learning management framework for enhancing students' science, mathematics and technology competencies in new normal.

3) Study competency assessment framework in science, mathematics and technology.

METHODOLOGY

The professional learning community for teachers' professional development training in classroom action research for enhancing students' science, mathematics and technology competencies in new normal were conducted in 3 phases.

1) Phase I: background and need survey.
2) Phase II: classroom action research and competency-based leaning/assessment design
3) Phase III: classroom action research investigation on competency-based leaning/assessment.

Target Group

The research involved 40 target group teachers: from schools in Maha Sarakham Province, Roi-et Province and Kalasin Province on the northeast of Thailand. All participants voluntarily participated in the research study.

1) 14 science teachers.
2) 13 mathematics teachers.
3) 13 technology teachers.

Research Tools

There were two types of research tool.

1) The survey questionnaire on teacher needs in classroom action research for enhancing students' science, mathematics, and technology competencies in new normal was five-point rating scale online survey, consisted of three parts: (1) personnel information, (2) opinion on ability to do classroom action research and (3) ability to do competency-based learning management and competency assessment.

2) The professional learning community record forms were open-ended form. These were used during the PLC processes for finding out a conclusion of the PLC meetings on classroom action research for planning in enhancing students' competency, designing of competency learning activity, designing of competency assessment, results of competency-based learning management and competency assessment, as well as, data analysis and report writing of classroom action research.

Data Collection

The research methodology employed in this study was a multi-phase design encompassing three phases.

3) In Phase I, the researchers used a quantitative approach by online survey the teachers on their background in teaching, experiences in classroom action research and competency-based education and their needs in classroom action research for enhancing students' science, mathematics and technology competencies in new normal. Then, the

survey data were analyzed for each item to identify teachers teaching background, needs in classroom action research for enhancing students' competencies and opinion on their own ability to do classroom action research, competency-based learning management and competency assessment.

4) In Phase II, the researchers used qualitative research using professional learning community (PLC) process to meet the teachers need in classroom action research and competency-based learning management and competency-based assessment. The professional learning team of each school including a model teacher who was the research target, a buddy teacher who was teaching the same subject with the model teacher, an administrator who was the head of department, a mentor who won Kurusapha (Teacher's Council) award, an expert who was a lecture from Rajabhat Maha Sarakham University. Besides, Rajabhat Maha Sarakham University provided 2 workshops for the target group teachers on competency-based education and classroom action research. After workshops the target teachers and their professional learning team had professional learning community meetings for planning on the competency-based learning/assessment and classroom action research. Then, the PLC record forms and the teachers' lesson plans were analyzed to categorize how do the teachers planned to enhance students' science, mathematics, and technology competencies in new normal and how do they assess students' competency.

5) In Phase III, the mixed method was employed. The researchers used qualitative research using professional learning community process to help the teachers improve their teaching and assessment. The PLC meetings were done several times after each or few teaching classes of each model teacher. The professional learning team of each school observed the model teachers' teaching along with discussed on students' works. The suggestions from the professional learning team were used for improving the teaching and competency assessment of the teachers. The PLC record forms were analyzed to find out how science, mathematics and technology teachers managed competency learning /assessment in new normal.

The quantitative approach in Phase III from the online survey on teachers' opinion of their own ability to do classroom action research, competency-based learning management and competency assessment was done to identify of each item.

Data Analysis

The quantitative data analysis was descriptive statistics, e.g., mean, standard deviation and percentage with the survey data. The qualitative data analysis was content analysis of PLC record forms, teachers' lesson plans and students' works.

RESULTS AND DISCUSSION

This research aimed to bring out the benefits of the professional learning community to: 1) conduct teachers' professional development training in classroom action research for enhancing students' science, mathematics and technology competencies in new normal, 2) study learning management framework for enhancing students' science, mathematics and technology competencies in new normal and 3) study competency assessment framework in science, mathematics and technology. The researchers started the research by survey 229 teachers in Maha Sarakham Province, Roi-et Province and Kalasin Province on their background in teaching, experiences in classroom action research and competency-based education and their needs in classroom action research for enhancing students' science, mathematics, and technology competencies in new normal. The background in teaching of the teachers is given as follows.

Table 1: Personnel information of teachers

Items	Number (person)	Percentage (%)
Gender		
Male	51	22.27
Female	178	77.73
Affiliation Area		
Maha Sarakham	119	51.97
Roi-Et	40	17.47
Kalasin	64	27.94
Others	6	2.62
Subject Teaching		
Science	91	39.74
Mathematics	86	37.55
Technology	52	22.71
Grade Teaching		
Elementary	25	10.92
Secondary	111	48.47
High school	89	38.86
Others	4	1.75

Table 1 show that most of the teachers are female (77.73%), their schools are in Maha Sarakham area (51.97 %) and teaching science subject (39.74%) in lower secondary level (48.47%). From all 229 teachers were only 40 teachers attended to participate in this research study as target group teachers. The researchers focusing inquired on the target teachers' opinion in their ability to do classroom action research and ability to do competency-based learning management and competency assessment in new normal. The results are as the follows.

Table 2: The teachers' opinion on their performance before attend the training

Items	$\bar{x}$	S.D.	Performance
Understanding in classroom action research	4.03	2.56	Good
Ability to do classroom action research	3.93	2.77	Good
Understanding in competency-based learning management.	3.75	2.32	Good
Ability to do competency-based learning management.	3.13	2.74	Average
Understanding in competency-based assessment.	3.22	2.56	Average
Ability to do competency-based assessment.	2.82	2.32	Average
Total	3.48	2.63	Good

As shown Table 2 the target teachers indicated their own ability to do classroom action research and ability to do competency-based learning management and competency-based assessment in new normal in "Good" performance ($\bar{x}$ = 3.48, S.D. = 2.63). This data implied that the target teacher had knowledge on classroom action research and competency-based education somehow. Therefor the researchers decided to hustle on training the target teachers to classroom action research and competency-based education through professional learning community. We did review the target teacher a little with one day workshop on classroom action research and one day workshop on competency-based education. Then after that the professional learning community process was implemented in designing classroom action research for enhancing students' science, mathematics and technology competencies in new

normal of the target teacher's professional learning team. The researchers analyzed data from lesson plans of the target teachers and the findings are as follows.

Table 3: The teachers' competency-based learning management in new normal

Subject Teaching	Competency Based Learning Models	Steps in Learning
Science	5E Learning Cycle	1. Engagement -teacher engage students to the lesson and review prior knowledge. 2. Exploration -students do hands on activities as preliminary investigation to generate scientific knowledge. 3. Explanation -students explain their understanding of concepts and the teacher corrects students' misconceptions. 4. Extension -students share information and ideas or apply their knowledge and skills to other disciplines or daily life. 5. Evaluation -teacher evaluate students understanding and progression as well as encourage them to assess their understanding.
	Problem Based Learning	1. Define the problem -teacher present problem scenario that reflect learning objective and the real world to engage student's problem solving. 2. Problem analysis – students discuss the problem in a small group, clarify the facts of the case and identify what they need to learn to work on the problem. 3. Conducting research -students brainstorm to find out possible solutions to the problem and test the potential hypotheses. 4. Knowledge synthesis -students bring the knowledge they have studied to the group for discussion. and synthesize the knowledge that has been learnt 5. Summarize and evaluate the value of the answer -each group of students summarize and evaluate the value of the answer whether be able to answer all the questions without doubt. If it's not, they are still questioning, knowledge must be sought out and they must conduct more research to answer the question. 6. Presentation and evaluation -students present their results. Teacher and the others assess the performance and reflects on the strengths and highlights areas that should be revised.

Table 3: (Cont')

Subject Teaching	Competency Based Learning Models	Steps in Learning
	STEM Education	1. Problem identification -students make consideration and identifying the problem includes discerning what is needed for problem solving or innovation. 2. Related information search -students investigate related information and ideas on sciences, mathematics and technology for problem solving or innovation. 3. Solution design - students apply the related information and ideas for problem solving or design innovation concerning available resources, restrictions and condition of the given situation. 4. Planning and development - students design sequence steps in problem solving or innovation and develop methods for problem solving or construct innovation. 5. Testing, evaluation and design improvement - students test and evaluate the problem solving method or innovation. The result may need improvement for an effective problem solving. 6. Presentation -students present ideas and steps in problem solving or innovation.
	General Instruction	1. Introduction -teacher engage students to the lesson, inform of purposes and stimulate attention. 2. Body -teacher recall student's prior knowledge, present information, and provide practices. 3. Closure -teacher and students discuss and summarize what have been learnt, conduct assessment and feedback.
Mathematics	IPST Teaching Model	1. Introduction -teacher assess students' prior knowledge. 2. Teaching -teacher teaching new knowledge to students. 3. Summarize -teacher and students summarize the main idea of the lesson. 4. Practice -students do practice worksheets. 5. Application -teacher and students discuss how to apply the knowledge into new situations. 6. Evaluation -teacher evaluate the learning result and knowledge applications of the students.
Technology	Project Based Learning	1. Presentation -teacher introduce students into the problem situation and students study relevant situation related to content in the lesson plan as a learning guideline. 2. Planning -students cooperative planning, brainstorming and discussion to find out the conclusion for the action plan. 3. Action -students conduct activities and write results report.

Table 3: (Cont')

Subject Teaching	Competency Based Learning Models	Steps in Learning
		4. Evaluation – teacher use authentic assessment to assess whether students are meeting the desired learning goals of the lesson plan.
	Think-Pair-Share	1. Think -teacher asks specific question to the lesson and students think about what they know or have learned about the topic. 2. Pare -student pairs with another student or a small group and then find out the answer of the question through 4 steps: 　2.1 Motivation -teacher introduce the lesson to students. 　2.2 Information -students study the lesson. 　2.3 Application -students test achievement of the learning outcome. 　2.4 Progress -teacher evaluate the students' learning achievement. 3. Share - students share their thinking with their partner and discuss for the final conclusion.
	STEM Education	1. Problem identification -students make consideration and identifying the problem includes discerning what is needed for problem solving or innovation. 2. Related information search -students investigate related information and ideas on sciences, mathematics and technology for problem solving or innovation. 3. Solution design - students apply the related information and ideas for problem solving or design innovation concerning available resources, restrictions and condition of the given situation. 4. Planning and development - students design sequence steps in problem solving or innovation and develop methods for problem solving or construct innovation. 5. Testing, evaluation and design improvement - students test and evaluate the problem solving method or innovation. The result may need improvement for an effective problem solving. 6. Presentation -students present ideas and steps in problem solving or innovation.
	General Instruction	1. Introduction -teacher engage students to the lesson, inform of purposes and stimulate attention. 2. Body -teacher recall student's prior knowledge, present information, and provide practices. 3. Closure -teacher and students discuss and summarize what have been learnt, conduct assessment and feedback.

Table 3 showed the competency-based learning management for enhancing students' science, mathematics and technology competencies in new normal of the target teachers included STEM Education, Problem Based Learning, 5E Learning Cycle, IPST Teaching Model, General Instruction and Think-Pair-Share. These teaching models overarching categories of inquiry, problem solving, self-direct learning, critical thinking, creative thinking, collaboration and communication which are important tools for students' competency development in science, mathematics and technology.

The target teachers' lesson plans analysis revealed competency assessment framework in science, mathematics and technology as shown in Table 4.

Table 4: The teachers' competency assessment in new normal

Subject Teaching	Competency Assessment Tool	Characteristics
Science	Activity	Students performed activity and teacher used rubric to score students' competency from the activity record or performance. The range of scores were 1-3 points according to science competency level.
	Worksheet	Students answered worksheet questions and teacher assessed students' science competency through rubric scoring. The range of scores were 1-3 points according to science competency level.
Mathematics	Practice	Students demonstrated mathematics problems solving and teacher assessed students' mathematics competency through rubric scoring. The range of scores were 1-3 points according to mathematics competency level.
	Activity	Students performed activity and teacher used rubric to score students' competency from the activity record or performance. The range of scores were 1-3 points according to mathematics competency level.
	Worksheet	Students answered worksheet questions and teacher assessed students' mathematics competency through rubric scoring. The range of scores were 1-3 points according to mathematics competency level.
Technology	Worksheet	Students answered worksheet questions and teacher assessed students' technology competency through rubric scoring. The range of scores were 1-4 points according to technology competency level.
	Activity	Students performed activity and teacher used rubric to score students' competency from the activity record or performance. The range of scores were 1-4 points according to technology competency level.
	Technology competency assessment form	The technology competency assessment form was 5 points rating scale for students' self-assessment on ICT competency area ICA 1-5 after each lesson plan.

Table 4 showed the competency assessment tools that the target teachers used for determine the students' science, mathematics and technology competencies in new normal were activity, worksheet, practice and assessment form. The tools shared common in 2 characteristics which are 1) using rubrics in scoring acquisition student's answers, problem solving and competency performance and 2) using rating scales for student self-competency assessment or for teacher assessment of students' competency performance.

After the completed, the target teachers were surveyed again on their opinion in ability to do classroom action research and ability to do competency-based learning management and competency-based assessment in new normal. The results are as Table 5.

Table 5: The teachers' opinion on their performance before attend the training

Items	$\overline{\times}$	S.D.	Performance
Understanding in classroom action research	4.63	1.84	Very Good
Ability to do classroom action research	4.40	2.53	Very Good
Understanding in competency-based learning management.	4.19	1.97	Good
Ability to do competency-based learning management.	3.99	2.65	Good
Understanding in competency-based assessment.	4.17	2.01	Good
Ability to do competency-based assessment.	4.01	2.37	Good
Total	4.23	2.53	Very Good

As shown Table 5 after the professional learning community for teachers' professional development training in classroom action research completed, the target teachers stated their own ability to do classroom action research and ability to do competency-based learning management and competency assessment in new normal in "Very Good" performance ($\overline{\times} = 4.23$, S.D. = 2.53). This indicated that the target teachers have developed ability in classroom action research, competency-based learning management and competency assessment.

CONCLUSION AND IMPLICATIONS

The research revealed the effectiveness of professional learning community on the teachers' professional development training in classroom action research for enhancing students' science, mathematics and technology competencies in new normal. The PLC process supported the teachers' collaborative working on every step of classroom action research for enhancing students' science, mathematics, and technology competencies. The PLC facilitated professional learning team to design and problem solving of classroom action research, competency-based learning activity, competency-based assessment, competency learning management, and classroom action research data analysis and report writing. The "new normal" things seemed bothered the target teachers at first. They worried about the online competency learning management, online classroom observation and online PLC meeting will not work well. The competency-based education requires students' inquiry, problem solving and performance. How could these be done online. Also, how could the model teacher expresses students' competencies to the professional learning team during the classroom observation since the camera stand still. Later, the teachers had changed their mind, mentioned the convenient of the online platforms that provide them to share the teaching videos to the professional learning team member who missed the actual class. Even the professional team members who do real time online classroom observation were impressed with the re-observation that they could go backwards and forwards the posted video to carefully observe on the target competency of students. As well as the online PLC meeting could be done easier than onsite meeting. The online PLC meeting could be done after dinner or weekend day!

The PLC provides expertise sharing and collaboratively working to improve teaching skills and the academic performance of students. The target group teachers felt more confident in conducting classroom action research, competency-based learning management and competency-based assessment after the training from high level to

highest level. The competency-based learning managements in new normal which they had designed were vary on the subjects they are teaching. The science competency-based learning management was according to 4 learning models: 5E inquiry, Problem Based Learning, STEM Education and general instructional method, the mathematics competency-based learning management based on only one learning models and the technology competency-based learning management was according to 4 learning models: Project Based Learning, Think-Pair-Share, STEM Education and general instructional method. While the competency assessment was shared as activity sheet, worksheet, practice and competency assessment inventory. There were two types of competency assessment tools: 1) rubrics to score answer quality, problem solving performance and competency performance of the students and 2) rating scale to indicate competency level of performance of the students or students self-assess their own competency level of performance. Those performances of the target teachers highlighted the powerful of PLC. The PLC leaded and scaffolded them in conducting classroom action research, competency-based learning management and competency-based assessment from the beginning. As well as the feeling that professional learning community team is right there to help, was really support the target teachers in their professional development. These confirmed Díaz-Maggioli (2004) statement "a career-long process in which educators fine-tune their teaching to meet their students' needs". The PLC is effective profession development as ongoing, intentional and systematic, highlighting the fact that only through sustained involvement. In such actions provide teachers effectively update their knowledge base so that it better relates to their learners' learning. (Guskey, 2000).

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