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STEM Education and Innovation for Teacher Development: New Challenges toward Thai Education Quality

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Abstract. This paper indicates STEM education and innovations as the key issues of teacher development in Thailand. Since 2017, the Ministry of Education of Thailand has implemented a reform to the in-service teacher training system. The key principles of teacher development consist of (1) school-based development model and (2) development of teacher. Firstly, School – Based Development model is applied to development process through the Professional Learning Community (PLC). Secondly, Development of Teacher is conducted based on individual need. In implementing the new reform policy, teachers will receive a budget of approximately 300 USD (10,000 baht)/person in order to register for training courses from the Teacher Development Unit that is qualified by Teacher Profession Development Institute (TPDI) or Kurupatana. Thus far, 2,659 training courses have been approved. In the year 2018, more than 270,000 teachers received in-service teacher training under the "Teacher Development Coupon" project which counted for 72.6 % of teachers affiliated with the Office of Basic Education Commission (OBEC). Interestingly, in 2017, there were 116 STEM-related courses which accounted for 6.31% of all training courses and increased to 203 STEM-related courses in 2018, notably 75% increase in the numbers of STEM-related training courses. Nevertheless, there were only 1,625 teachers trained in STEM-related courses which accounted for 0.46 % of total numbers of teachers' received training. This suggests New Challenges toward Thai Education Quality.

Keywords: Teacher development, STEM education, Professional learning community
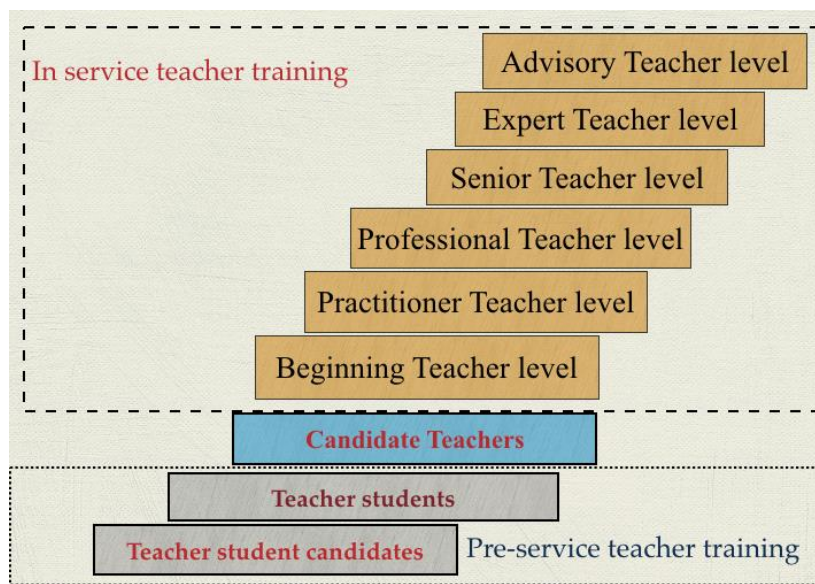
1. Introduction

The society is experiencing a rapid change due to the development of digital technology. This dynamic of progress has led to the phenomenon so called "Disruptive Technology" in which numbers of businesses and enterprises are replaced with the new industry. Few examples we have seen are the shutdown of Kodak Company in 2011 when digital camera hit the market, numbers of television channel had to closed down because the habitual change of people in watching content through smartphone instead of the traditional television screen and many newspapers companies continue to stop printing its content. Meanwhile, "Fintech" or Financial Technology as we know, the emerging

industry that uses technology to improve and deliver services and activities in finance. Today, we could transfer money with just a swipe of our finger on a tiny screen in which the result is the inevitable closing down of many branches of the bank and disruptive unemployment of bank workers (World Bank, 2012). Moreover, inter-state movement of labours and mass-promotion of tourism that come along with low-cost logistic options have made it impossible to ignore the need of learning and adaptation to change. Therefore, it is vital for any state to be alert on ensuring that its population is ready and equipped with the quality to live in the increasingly interconnected and competitive society. The attention is, then, drawn to the most important element of human development, the quality of education management system for the future. Though, it is unclear to where the future holds but with the rapid change, the only way to ensure future quality of the education is begin with the quality of teacher development. It is undeniable that teacher is the foundation to education quality.

The development of teachers' learning management and teachers' teaching ability development are the key factors that could reflect the quality of the teachers (Barber and Mourshed, 2007). Thailand's Ministry of Education attaches importance to the quality of teachers as it can be found in the government's efforts to produce quality teachers through scholarships granted to those who wish to seek a career as a teacher (Erawan, 2019). The scholarship seeks to recruit outstanding and highly performed high-school students whom are put under the job insurance system whereby their career as a teacher is guarantee after their graduation (OTEPC, 2017). The project has begun since 1985 but every project upholds the same principle which is aiming at recruiting well-rounded and achieved high-school students to enter the teacher system .2015Hence, once the teacher students graduated from Teacher Institutes, he/she will enter the career / profession path of teacher. As shown in diagram .1

Diagram 1 Career/Profession Path of Teacher Profession in Thailand

From the 1st diagram, the teacher's career path began as a Beginning teacher, which during the initial stage of the career, a new teacher will spend two years under supervision of the board of Directors. Once a new teacher passed the assessment evaluation, a new teacher then become fully appointed as a teacher. The teacher's career

path will take at least 5 years of working time for every period of promotion to a higher level (Teacher Profession Development Institute database).

2. In-service teacher training system

The Ministry of Education of Thailand has implemented a reform to the in-service teacher training system since 5th July .2017This new teacher development system is a major change in the history of Thai teacher development. The key principles behind this change are the following concept;

2.1 School – Based Development model is applied to the development process.
The essential tool for this method of development is the Professional Learning Community (PLC) (Du Four and Fullan, 2013). The mentioned process is as followed:

Step 1Team set up. Teachers must gather to work together as a team. The team could consist of at least 2people to about 5people. The team that decides to work together should have similar area of interest on learning problems of students for them to work together throughout the academic year. The team will be responsible for the selection of students 'problems as a starting point in their efforts to find solutions to their students' learning problems. This activity will be centered on respecting and accepting the ideas of everyone because success or failure of the project will belong to the team. The characteristics of team building consists of the following components:

(1) Model teacher will take the role of a team leader and will be a key person of the team. He/she will be in charge of arranging meetings for brainstorming ideas design prototype solution to the selected problem. Then, the Model teacher will formulate the ideas jointly designed by the team into a learning management plan, producing media, preparing for practice, preparing assessment test and necessary equipment. The Model teacher is responsible for applying the jointly developed plan to his/her classroom. The team members will take the role in observing the class while Model teacher according to the learning management plan. The team will reflect and evaluate the observation together.

(2) Buddy teacher will act as a "Partner of Buddy" who will co-think, co-do and co-reflect. The number of Buddy teachers could be from 1to 4people. The Buddy teacher must be involved in the planning, designing and taking part in the solving of student learning problems. They will have to observe the class and analyze the outcome of the implementation of the learning management plan in order to improve the plans and yield the best outcome for students' learning abilities.

(3) Administrator staffs are responsible for learning, designing, and solving students' learning problems. Administrator staffs will also help facilitate any necessary needs to ensure a smooth and convenient team work with minimal obstacles

(4) Mentor acts as an academic advisor. Being a mentor in the work of the team helps providing advices on designing activities to solve student learning problems. The Mentor may be a retired teacher or Superintendent, the number of mentors may be more than one person but should not be more than 3 persons because it may cause problems in managing the team.

(5) Expert acts as a resource person with specialization in the field such as in early childhood development, learning disabilities, gifted instructional design, digital learning design, theme-based learning, message design, instructional design, literacy, thinking

skills development, authentic assessment and etc. The number of experts can be more than one person but should not be more than 3 persons because it may cause problems in managing the team. The experts mostly come from university professors.

Step 2 Student Learning Problem: in this step the teachers will together select 1key learning problem in the classroom as a development goal that the team would like to solve or improve. The nature of the problem should be considered as essential to students; learning abilities or competencies related such as, but not limited to, Critical thinking skill, Critical thinking skill, Observation skill, Writing skill, Literacy skill, Discussion skill, Problem solving skill, Communication skill, Science literacy skills, STEM and etc.

Step 3 Lesson design is a collaboration of the Professional Learning Team (PLT) in order to brainstorm ideas and design lessons that will enable the change of better learning behaviour of the target student group. In designing such lessons, the team will have to acquire full capacities of knowledge in pedagogy (Pedagogy), learning psychology, instructional media, learning evaluation, content knowledge and technologies.

Step 4 Lesson plan implementation and classroom observation is an implementation of learning management plan that Professional Learning Team has jointly designed into practice. The members of Professional Learning Team will observe in the classroom where Model teacher applies the learning management plan that was designed together with the team members. The goal of observing the class is to check the results of the lesson designed whether it could create a scenario that would improve or solve students' learning difficulties. During the observation, PLT has to be alerted on Theoretical sensitivity about how students have responded to the learning activities designed and also observe how the teacher expressed towards the students as well.

Step 5 After class reflection dialogue is a process where PLT organizes meeting for sharing and reflecting the results witnessed from the observation of the class. At this step, it will become clear on the results of the learning management plan. The members who observed the class have to exchange views to develop and come out with an even better learning management process after the experiment. The issues/difficulties reflected in the class observation will be redesigned into the next lesson.

Each teacher will have his/her own implementation of these five steps and, most importantly, his/her own team to work together. This team and this process will continue and repeat on achieving the initial goals and targeted problem until they achieve "best practice" for solving learning problems of the targeted student group.
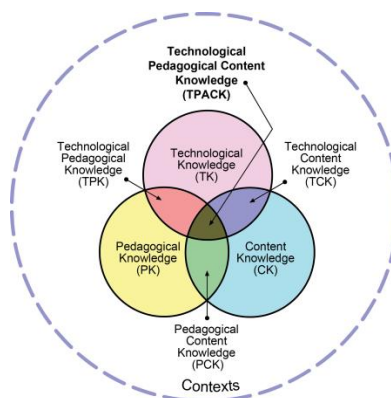
2.2 Development of Teacher
Development of teacher is teacher's development based on individual need. In Teacher development to keep up with changes, all teachers are required to make their Individual development plan (ID Plan) annually through the School Principal's approval consideration. Teachers will receive a budget of approximately 300USD (10, 000baht) in order to register for training courses from the Teacher Development Unit. There is a condition in which the teacher must attend at least one 20hours a year for 5years, the training hours are 100hours.

Ministry of Education has set up an agency responsible for overseeing curriculum standards that will be used in teacher development which is called "Teacher Profession

Development Institute (TPDI) or Kurupatana." TPDI is responsible for establishing standards for teacher development. There are 4main standards including (1) Curriculum standard, (2) Training standard, (3) Keynote speaker standard and (4) Target audience standard.

Curriculum standard is the key conceptual framework for every development unit. All training institution must use the conceptual framework set as a central concept for designing training curriculum. Between 2018-2019, the Minister of Education has set the framework of the curriculum to be "Technological Pedagogical and Content Knowledge (TPACK)", which is the concept of Mishra and Koehler (2006).

TPACK stands for Technological Pedagogical Content Knowledge. It is a theory that was developed to explain the set of knowledge that teachers need to teach their students a subject, teach effectively, and use technology (TPACK, 2012).

(http://tpack.org) (Misha and Koehler, 2006)

Figure 1 Technological, Pedagogical and Content Knowledge Concept

Training standard refers to the criteria set for an agency that can be responsible for the development of teachers. The agency will be to be training institute must be under 3 categories which are (1) educational institutions (University, College and school), (2) private organizations (Company, Private sectors) and (3) public academic entities of Thailand (Yamaksikorn, 2016; Yuenyong, 2019). All units wishing to be teacher development units must register with TPDI before proceeding. There is also a limit to the number of teachers whom can be trained per class which must not exceed 150 people. There is a proportional allocation of number of speakers per number of teachers attended the training which is at least 1 speaker to every 30 attendees. This means if there is 60 attendees, there must be at least 2 speakers.

Table 1 Hosts of curriculum management for In-service teacher training in Thailand on 2019

No	Hosts of curriculum management	Number	Percentage
1	Private sectors (Company, Foundation)	424	47.59
2	Education Institute (University, College and School)	422	47.36
3	Government Sectors	45	5.05
	Total	891	100

(TPDI database on September 26, 2019)

Keynote speaker standard refer to the specification of the minimum qualifications /criteria for speakers in the teacher development curriculum. It must consist of at least 2 speakers. The composition of the speakers must consist of (1) A person who has completed a minimum of a Master's degree in a subject that the person will be a speaker and holds a position at the level of Senior teacher level or Assistant. Professor or more (2) persons with more than 10 years of school/college teaching experiences.

Target audience standard refers to the classification of teachers that will be developed into 3 groups consisting of teachers who want to develop themselves in new subjects that they have never learned before. This type of course will be suitable for teachers who want to learn at a Basic level. Teachers who want to learn things they have previously known. This is suitable for the Intermediate level curriculum and for the teachers who need a deep research and development. They will be suitable to attend an advance level course.

3. Statistics of the teacher development training program in 2018

In the fiscal year B.E. 2561, the Kurupatana (Teacher Profession Development Institute: TPDI) conducted a curriculum certification/evaluation of training courses There has been 3,331 institutes proposed to be teacher training unit. 1,837 training courses have been approval by Kurupatana (TPDI) and 1,837 training courses failed to meet the criteria. In addition, there are 2departments that overlook teacher issues which proposed training courses for approval from the Kurupatana, which is the Bureau of Personnel Competency Development and Vocational Personnel. Office of the Vocational Education Commission. There were 84accredited courses by these two offices. Meanwhile, the Office of Non-Formal and Informal Education successfully proposed 20accredited courses, totalling 1, 387accredited courses and among this approved courses 1, 801are traditional training courses, 36are online courses which are of 3 training levels: Basic, Intermediate and Advance

Table 2 Approved curriculum for in-service teacher training in 2018

No	Contents	Curriculum content level			Total	Remark
		Basic	Intermediate	Advance		
1	Science education	147	63	18	224	3 On lines
2	Mathematics	93	32	10	135	
3	Thai language	132	19	2	153	
4	English language	132	20	2	154	17 On lines
5	Malay language	1	0	0	1	
6	Japanese language	6	1	0	7	
7	Chinese language	5	1	0	6	
8	Work, Career and Technology	66	28	6	100	
9	Social studies, Religion and Culture	79	19	8	106	
10	Health education and Physical education	67	16	3	86	

Table 2 (Continued)

No	Contents	Curriculum content level			Total	Remark
		Basic	Intermediate	Advance		
11	Art education	16	1	2	19	
12	Music and dance	17	4	0	21	
13	Student development activities	74	24	2	100	
14	Early Childhood	91	19	1	111	2On lines
15	Special Education	21	4	1	26	
16	Interdisciplinary content	231	54	9	294	8On lines
17	Industrial Education	2	5	2	9	
18	Business Administration	10	2	3	15	
19	Fine Art	0	0	0	0	
20	Home Economics	1	1	0	2	
21	Agricultural	1	1	0	2	
22	Fisheries	0	0	0	0	
23	Tourism Industries	3	0	0	3	
24	Information and Communication Technology	43	24	0	67	
25	Others with relevant with education	72	11	5	88	
	Total	1,311	348	74	1,733	30 On lines

Table 3 Number of in-service teacher training curriculum in 2018 – 2019

No	Number of Curriculum in year	Number	Percentage
1	2018	1,733	39.14
2	2019	2,695	60.86
	Total	4,428	100

4. Training Course Approval Results 2019

The Curriculum Evaluation Working Group for Teacher and Educational Personnel Development under Kurupatana (TPDI) has examined and considered 3, 282training courses and has approved 2, 659courses. There were 587courses that did not pass the assessment criteria, the details are summarized as follows:

Table 4 Delivery mode of in-service teacher training curriculum in Thailand in 2019

No	Delivery mode of training	Number	Percentage
1	Face – to – Face delivery mode	2,528	93.80
2	On – line delivery mode	167	6.20
	Total	2,695	100

Table 5 Curriculum content level for in-service teacher training in Thailand on 2019

No	Curriculum content level	Number	Percentage
1	Basic content level	2,308	84.60
2	Intermediate content level	363	13.50
3	Advance content level	24	0.90
	Total	2,695	100

Table 6 In – service teacher training curriculum classify by education level in 2019

No	Curriculum classify by education level	Number	Percentage
1	Early Childhood teachers	206	7.64
2	Elementary school teachers	1,233	45.76
3	Junior high school teachers	866	32.13
4	Senior high school teachers	352	13.06
5	Vocational school teachers	21	0.78
6	Special Education teachers	11	0.41
7	Nonformal Education and Informal Education teachers	6	0.22
	Total	2,695	100

Table 7 Number of STEM Education curriculum for in-service teacher training on 2019

No	Curriculum content	General science	STEM Ed.
1	Science Education curriculum	554	203
2	Percentage of Science Education	100	36.64
3	Percentage of In-service teacher training curriculum	12.51	6.69

Table 8 Number of STEM Education curriculum in 2018

No	Curriculum content	General science	STEM Ed.
1	Science Education curriculum	224	116
2	Percentage of Science Education	100	51.78
3	Percentage of In-service teacher training curriculum	12.93	6.69

In 2018, there were 116STEM-related courses, accounting 6.31% of all training courses (Table 8) and increase to 203 STEM-related courses or 36.64 %. There were 1, 625 teachers trained in STEM-related courses which accounted for 0.46 percentages of total numbers of teachers' received training.

In the year 2018, 279, 230teachers received training under the "Teacher Development Coupon" project which counted for 72.6 percentages of teachers affiliated with the Office of Basic Education Commission (OBEC).

Budget allocated for the development under the "Teacher Coupon" project as follows:

Table 9 Show the budget amount for training under the "Teacher Development Coupon" and the number of teachers that participated in the program:

Table 9 Total number of teachers and budget for in-service training through "Teacher Development Coupon" in 2016 – 2018

No	Year	Budget (Bath)	Number of Teachers	Percentage of participants
1	2016	8,723,356,300	No data	No data
2	2017	1,219,352,611	175,987	49.44 %
3	2018	2,127,340,145	279,280	72.6 %

From Table 9 shows that Number of teachers undergoing self-development. There are higher developments in 2017, with 49.44percentages of teachers applying for training and increasing to 72.6 % in 2018.

From 2017, all teachers can choose training courses according to their own assessment of what is needed to be improved in their opinion through online system. Their decision has to be consulted with the school principal as well in order to make sure that the skills they are developing are in line with the school direction.

Establishing shared responsibility of teachers in improving the quality of learning of students through a community process of professional learning (Professional Learning Community: PLC). The compulsory practices set for all teachers in Thailand to apply are 13 KPI, those set of KPI are need for teacher who want to promote a higher rank of teacher career paths. Those KPI are as follows:

(1) Instruction Design consists of series of activities
        a. Curriculum creation and / or development (Curriculum research and development)
        b. Learning Design consists of Learning Unit Design, Lesson plan development, Individual lesson plan for disability students,
        c. Instructional strategies design
        d. Learner quality development
        e. Creating and developing innovative teaching media Teaching technology and development of learning resources
        f. Learning measurement and evaluation
        g. Research for learning development

(2) Classroom management system
        a. Management of students in the responsible class
        b. Establishing a system to help supervise and assist learners
        c. Preparation of information and class documents or course documents.

(3) Self-development and professional development
        a. Access to self-development as needed (Teacher Development Coupon)
        b. Student learning quality development through professional learning community process (PLC)

6. Conclusion

In examining and analyzing the changes in the process and practices for in-service teacher training in Thailand, it appears clearly that the activities set to be a Key Performance Indicators (KPI) all require teachers to take action and implement it themselves, whether it is the curriculum development, creating media, designing classroom activities, media development, enhancing learning competencies of students, conducting assessment and evaluation of student learning, conducting researches, looking after the students, organizing care-taking session for students, preparing information for everyday class and designing self-development and professional development plans. Each teacher is required to perform these activities regularly and consistently throughout the year. The school principal will evaluate the performances of these underlying indicators at the end of every academic year. These performances will be considered in relevant to salary and promotion to a higher academic ranking. This in-service teacher training model requires teachers to conduct these practices for at least 5 years. If this is completed intensively as planned, the result will be directed and effectively contributed to the enhancement of students' learning capabilities and quality. Nevertheless, how long will this change of model co-exist in Thai education system will depend on the extend people are ready to adapt to change because this reform will also require the evolvement of new working culture and intensive collaboration between

teacher and school board. Will these targeted outcome and conditions really happen? It will certainly be a challenge for the relevant stakeholders. For this to last or to be able to observe whether the change will be effective, we require the policy makers to stay firmed on their will and decision they have made. It is essential to not be shaken by the political trend and adhere to the initial concept of teacher development. More importantly, the teachers have to set by heart the consequences and outcome that each project will have on the students as the first priority.

It is inevitable to expect that this change will certainly have effects on work culture and lifestyle of teachers and school executives. In another word, these reforms and innovative change will be a great challenge to Thai education system. Its consistence implementation for at least ten prospective years, its outcome will truly be meaningful to the development of Thai education quality.

The true meaning of educational reform or change in education is the implementation of a new policy into practices. The new policy means integrating new ideas, new courses, new teaching materials together and enforce them into action in order to yield effective and practical results in the classroom. This means that the key player is the teacher who must be ready to change and adapt their traditional beliefs and teaching strategies by emphasizing a student-centered principle. Their strategy and teaching should be formulated to best fit the uniqueness of students in each class. Professional Learning Communities will lead to an effective development to the classroom. It is considered as a tool to true reform of education. However, to what extend and when will we accomplish our goals will certainly rest in the hands of Thai teachers.

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