THE STATE OF STEM EDUCATION POLICY IN NORTHERN REGION, THAILAND

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Abstract

The purposes of this paper aimed to study the state and the barriers of STEM educational learning management for primary and secondary levels in Northern Region of Thailand. The research methodologies consisted of (1) the synthesis of related document about STEM education in Thailand, (2) the interview of teachers and students from 8 schools which were the centers and networks of STEM education in Northern Thailand. The findings showed that although the Ministry of Education had carefully designed STEM policy by designing STEM education network, implementing the policy and its strategies, and designing the curriculum teacher developing plans, but the practices of STEM education in schools didn't go as planned due to the lack of learning resources and budget and supporting from the parents. Moreover, the directors of some schools hadn't paid much attention towards STEM teacher development and learning management.

Keywords: State; STEM education Policy; Northern Region

Introduction

Since the Mutual Recognition Agreements for skilled labour in ASEAN (MRAs) has been officially made, the seven careers which are engineering services, nursing services, architectural services, surveying qualifications, accountancy services, dental practitioners and medical practitioners were permitted to work borderless in ASEAN community (ASEAN, 2013). To analyse the qualifications of those skills, it is found that the labours of all occupations have to be knowledgeable in STEM education in order to work qualitatively. Thailand as one of the ASEAN members has realized the importance of STEM education to prepare the human resources to be competitive labours in the future. Therefore, the policy of developing science and technology has been announced to support Thailand 4.0 era. (IPST, 2013).

However, the previous Thai educational management had not met the demands of the international labor market neither in quantity nor quality. From IMD World competitiveness 2016, in educational quality, Thailand was revealed to rank at 52nd place from 61 countries around the world (PRD, 2016). Moreover, from the past six times of PISA tests, Thailand scored under the average score of OECD score (500 scores) or was listed in a low-level group (IPST, 2017).

In addition, attending to TIMSS which evaluates the students' science and mathematics knowledge from presented curriculum, Thai students could not pass the IEA's average score or the scores were in the lowest level (IPST, 2015). These reflect that Thai education does still not find the right answer for the international labour market and the skills of the students are not well developed.

The strategies of developing science and technology played the important role to improve students' potentiality in science, mathematics and technology and as a base to develop the country. From the 6th Thai-US Roundtable Meeting which was on 14th September 2012, it resulted that the educational innovations from the US would be brought to gear up Thai educational learning management organized by IPST:Institute for the Promotion of Teaching Science and Technology. In association with Minnesota University and the University of Oklahoma, Thailand was precisely supervised to develop STEM knowledge for Thai education. The recent government also declared STEM education policy to be the curriculum strategy and as the educational innovation (Thawat, 2012).

According to the policy of National STEM Education was driving by IPST, STEM Education was managed to develop the quality of Mathematics, Science and Technology's learning management. But, the results of PISA test in 2012 and 2015 is showing in the following table.

Table 1: Comparative PISA 2012 and 2015 in 3 Literacy of Northern Area

Literacy	Year					
	2012			2015		
	Upper Northern	Lower Northern	Thailand's average	Upper Northern	Lower Northern	Thailand's average
Math	431	433	427	408	423	415
Science	437	428	444	417	402	421
Reading	431	425	441	405	388	409

Source: PISA 2015, the conclusion of PISA results Report

As reported by the table, the average score of the schools in upper Northern Thailand and lower Northern Thailand was lower than the National average score especially in Science subject and reading. In 2015, the score had continuously dropped down. It showed that even though there were many schools interested to register in STEM education network, the process of managing STEM education in class were not yet to develop the skills for the students particularly thinking skill. As a consequence, the studies of the status and factors which affect STEM education's learning management in Northern Thailand was needed. Northern Thailand included many important economic provinces which their borders were attached with Laos and Myanmar. They were also various in geography, society and tradition. Therefore, it was significant to arrange the STEM education curriculum to be relevant to the environment. In order to prepare the students to be skillful labors in ASEAN, the 21st century learning management had to be activated.

The main office of STEM education in Upper Northern Thailand is Yupparaj Wittayalai School in Chiang Mai province and Lower Northern Thailand is Pitsanulok Wittayakom School in Pitsanulok province. In 2017, there are more than 400 schools, primary, secondary and high school, under different agencies: Office of the Basic Education Commission (OBEC), Private agencies and Local administration, has joined as the members of STEM education network. Mr.Boomserm Suriya, the chairman of Upper Northern

Thailand STEM education network center, said that "the center desires to have the students continuously participate in STEM education activities. However, PPST has given limited amount of money that the center has to send the project to OBEC to gain more financial support. OBEC can help only just some part and we are not sure whether the support will be steadily done or not".

The Purposes of this study

From the importance of driving STEM education policy in Northern Thailand and STEM Education policy, in this paper aimed to (1) study the state of STEM educational learning management for primary and secondary level in Thailand, (2) explore the problems of the state in STEM education in Northern Region of Thailand.

Research Methodology

The methodology of this research was divided into two parts:

(1) Analyse the relating document which was about STEM education in Thailand, then classified in three aspect: strategies of STEM Education, policy implement, teachers will provide all the material for students. as well as, curriculum and teacher training.

(2) Conducts the Individual Interview and Group Discussion, the samples of the research were two regional STEM education centers, 8 STEM Education Network Schools in Chiang Mai and Pitsanulok provinces, 16 teachers and 64 students. The research tool was the interview which the researcher created based on the IPST's strategies of STEM education and the data was analysed by the recording of the interviewees

Research Findings

1. The state of STEM Education for Primary and Secondary levels in Thailand

1.1 The strategies for Thailand's STEM education.

In 2013, IPST announced the strategies of using STEM education to develop the educational system to be STEM education. The strategies consist of four main issues:

1. All organizations including government, state enterprise and private sector should be part of STEM education. The government should introduce

measures for supporting STEM educational management. The private sector should also sponsor STEM education as part of the Corporate Social Responsibility (CSR)

2. Managing STEM activities for every educational stage, the analysing skills and real-life problem solving should be contained regardless of location.

3. Teachers and other educational personnel should be developed to be able to manage STEM as learning activities in classroom. Furthermore, the opportunity to meet STEM professionals or STEM ambassador should be provided for them to have the proper advises.

4. The national and school evaluations should be changed to comply with STEM education.

According to the strategies, it can be said that running STEM education in Thailand needs the cooperation from many organizations. Besides, STEM innovations can help pushing teachers to develop themselves and their teaching techniques from old-fashion way into the integrating way which leads to the skills of analysing and problem solving.

Moreover, From the strategy of STEM education in Thailand, IPST has established some departments to operate STEM education which are the National STEM Education Center, Regional STEM Education Center and STEM Education Network Schools. Each department has different role in STEM education as followed.

1. The National STEM Education Center is authorized by IPST. The main duty of the center is to improve the system to support STEM education for Regional STEM Education Centers and the schools in network. It has to raise the awareness, hold STEM educational seminars and settle the exhibitions in areas. Also, by the policy of IPST, it has to provide the development courses for administrators, teachers and educational personnel in provinces. In addition, the courses to improve the STEM experts and supervisor networks was be arranged along with the evaluation system.

2. All 13 regional STEM education centers located in large schools in selected provinces. The roles are to be the IPST's resource centers and deliver academic supports from IPST to teachers and educational personnel in the regions. Further, the regional STEM education centers works as coordinating centers in regions. The main duties of regional STEM education centers are (1)

to exchange information in order to create regional collaborative learning (2) to be the resource centers supplying public relation media and STEM learning media, and to coordinate and propagate the news between IPST and provinces (3) to be the coordinating centers for STEM ambassadors and other cooperative departments in regions.

3. STEM education network schools are the schools in Primary Educational Service Areas and Secondary Educational Service Areas in the provinces that operate STEM education centers. These schools are the STEM school models which Science, Mathematics and Technology subjects are integrated with STEM education. In addition, in each area, IPST has been chosen six schools to be the networks of STEM education networks includes two primary schools, two secondary schools and two educational opportunity expanding schools. Therefore, there are 78 schools around the country are in STEM education network.

Additionally, there are the network of universities of academic mentors, supervisor network and academic mentor network. There also are iSTEM and STEM Hall of Fame to support the operation of STEM education to access into every school in the country (IPST, 2014*)*.

From the stated patterns and structures of STEM education policy in Thailand, it shows that IPST, the main department to impel STEM education, has decentralized the authorities, responsibilities, activities and budgets to the regional STEM education centers with consideration of the contexts and demands in different areas. As a consequence, the teachers and educational personnel can practically manage STEM education activities in classroom.

1.2 STEM education policy implementation

Since the current IPST's STEM educational implementation, the topic has been more often discussed in Thai society. Thus, the Ministry of Education appointed three committees for STEM educational learning management in schools in order to establish the same direction for STEM educational learning management which include:

1. The Administrative Board of STEM Educational Learning Management in schools. The Minister of Education is the president. The Deputy Minister of Education is the vice president. The Director of Bureau of Policy and Strategy, Office of the Permanent Secretary of Education is the secretary.

Responsibility: Controlling the policy, direction, measure and method to process the STEM educational learning management in schools. Following up the implementation and also giving comments and suggestions to the committees. Appointing the subcommittee or committee for operating in field.

2. The Committee of Developing STEM Educational Learning Management Curriculum in Schools.The director of Mahidol Wittayanusorn School is the president. The deputy director of Institute for the Promotion of Teaching Science and Technology (IPST) is the vice president. The representative of IPST is the secretary.

Responsibility: Studying, analyzing and defining the definition of STEM education. Developing the curriculum of STEM educational learning management in schools.Evaluating the curriculum development and coordinating for cooperation from the related departments.

3. The Committee of STEM educational Learning Management in Schools. The secretary general of the Basic Education is the president. The assistant director of Institute for the Promotion of Teaching Science and Technology is the vice president. The deputy secretary general of the Basic Education is the secretary.

Responsibility: Bringing the curriculum from the STEM curriculum development committee to run the policies of STEM educational learning management in schools. Following up and evaluating the progress and success. Reporting the results to the administrative board (Office of the Minister, 2016).

As mentioned previously, it can be stated that there are many associations from various departments parted in STEM educational policy implementation. The responsibilities are clearly divided. Consequently, the abilities to control and examine the learning management quality are higher. Furthermore, the operational direction and supports were be performed on the same pace.

1.3 The curriculum and teacher training

The STEM educational curriculum is one of the innovation forms which integrated 4 subjects: science, mathematics, engineering and technology together. STEM activities were provided into three patterns which were (1) setting STEM as the extra-curriculum activities, (2) integrating with science and mathematics subjects, and (3) arranging STEM as an alternative subject. Therefore, the learners can adjust the knowledge for daily life and to solve the

real problems in life. Through the project-based learning or problem-based learning, it was expected that with STEM education skills, the learners can develop the progress or the productions that would be beneficial for living life and work.

STEM educational curriculum management was operated by the Committee of Developing STEM Educational Learning Management Curriculum in Schools, in association with Mahidol Wittayanusorn School and IPST. The curriculum was organized based on the indicators of science, mathematics and technology subjects from the Basic Education Core Curriculum B.E. 2550. Each STEM education activity consists of the necessary 21st century skills such as analysing skill, communication skill and problem-solving skill. Else, STEM education is integrated with other subjects turning them to be the alternative subjects and clubs (IPST, 2015).

In order to improve STEM teachers, IPST and the Office of the Basic Education Commission are in charge of developing science, mathematics and technology teachers to be able to change and manage the STEM learning activities in to the right way and have better understanding about STEM education. To illustrate, IPST is a department that established the national STEM education center, defining the visions, missions and strategies as well as drawing the operating measures. The 13 regional STEM education centers are the units to build and develop the qualities of human resources for STEM education in their areas. Moreover, they try to expand STEM education network schools to cover all educational service areas by using **"Training of the Trainer"** in which the core trainers were be trained to train the local trainers and STEM teachers, including the administrators and the supervisors. At the same time, students, parents and teachers had an opportunity to learn, understand and realize the importance of having STEM educational learning management in schools. And, the teachers who were responsible for STEM activity in schools had to be qualified from IPST training course.

Moreover, IPST had arranged the activities that help developing teachers by using Distance Training through Educational Television. But, the cooperation of STEM education network nowadays does not connect only the schools in the country but also with schools and universities abroad. For example, the cooperation from schools in New Zealand and England, the supports from

Mahidol University, Chiang Mai University and Chulalongkorn University establish the relationship with schools in Chiang Mai provinces and Bangkok.

The overview of curriculum and teachers developing ways receives the positive feedback from schools around the countries. Teachers who are trained by the STEM education network representatives and also taken care from university mentors network can manage the content of STEM education activity to be various and more related to the context of the environment. This will affect a lot in future STEM educational development in Thailand.

2. The Problem of the State in STEM education for primary and secondary levels in Northern Thailand

STEM is a government's policy to follow the Roadmap to THAILAND 4.0, in order to get out of the middle-income country and become one of the high-income counties. As a consequence, Ministry of Education has made a proactive movement, purposing to generate the students' analysing skills via STEM education in which Sciences, Mathematics, Technology and Engineering were first officially integrated. Therefore, teachers needed to change their learning management focusing more on the integrations.

2.1 STEM educational driving policy

1. The basic of STEM educational driving in schools

In selecting regional STEM education network schools as the samples, it was found that most of them are the extra-large schools in affiliation of Office of the Basic Education Commission and also are the regional Sciences centers. There was some advantages that made them the proper choices of being STEM schools. For example, buildings and maintenance was ready to be used and scientific experts are enough provided. Moreover, from the interview found out that the regional STEM education centers were also the schools in IPST's science program and involved in some important projects of the agencies. These components took significant parts to be able to launch as regional STEM schools immediately. Then, the budget, media devices, technology and teacher development were fully provided, the administrators promote the policy continuously. Consequently, The schools with stronger back-ups took the policy seriously and set it as the strategy of developing the

student's potential. In some extra-large schools also built the cooperation with some private organizations also were interested in developing STEM education such as British Council which sponsored a study trip for administrators and teachers to have a STEM visit in England. Besides, Chevron Company arranged the teacher development seminar and allocated budget and learning media for the schools. Some administrators prioritize STEM education policy although their schools are not in the regional STEM network. They spent all opportunities and cooperate with other organizations to improve the teachers and students' potentiality.

For STEM education network schools, it was different. In some large scale schools, STEM education has been activating for such a time, while some normal secondary and primary schools haven't had any experiences about STEM activities before. However, some administrators and teachers didn't see the importance of STEM education as much as they should be. From the interview, teachers acknowledge the existence of STEM education in schools but there still were plenty of administrators and teachers who lacked of knowledge and understanding about STEM. Accordingly, the encouragement of STEM activities was neglected. On the other side, as the STEM network schools didn't receive the provided media and enough budget so the continuity of STEM activities was abandoned. Some schools view that STEM education was the teachers and students' burden not an educational innovation.

It's clearly to be seen that realizing and understanding the policy lead to the performance in schools. This reflects to the administrators' supports for STEM education differently. And it showed the different ways of processing STEM education in each school. The schools that used to be the regional science centers turned to be regional STEM school centers authorized by IPST were better in management.

Withal, forwarding the Ministry of Education's STEM education policy to IPST and regional STEM education centers were not effective enough that the affiliations of the school lack of knowledge and importance awareness. They also couldn't provide schools in academic issues, budget, and personnel development: teachers and supervisors. Consequently, operating STEM education and managing STEM to integrate with other

subjects was the collaboration between STEM centers and schools directly. This kind of cooperation presents the shortage of performance association. Therefore, STEM driving in regions depends on the STEM activities the regional STEM education centers provide, the supports from administrators in each school and the readiness of the schools.

2. Support from parents

In order to get better results of implementing STEM education's policy, parent network plays the important role on STEM education. From the interview of the teachers and the students from eight schools, it was found that some of the parents didn't understand the concept the STEM education. They saw STEM education as a burdensome for students that it encroaches upon their university entrance preparation time and didn't give the support on STEM education activities. On the other hand, most of the schools have announced the policy to parents via parent network association. Parents also took part as STEM ambassadors in training programs. For example, introducing the STEM education occupations for student to learn such as dental practitioners, engineering services and agriculture services.

The sponsoring from parents encourages teachers and students to invent the new inspiration which drove STEM education in schools became stronger. This reflects that STEM education policy is accepted and obviously practiced. It can be said that parent network is important to push forward the policy, because teachers created more activities and better learning environment.

3. Budgets allocation

The schools that provided STEM education received the budget support from two channels. The first channel was from IPST and it was transferred via the regional STEM education centers. The budget was shared equally depends on the number of the school network. Secondly, schools allocate budget by themselves. The schools that were supported by the administrators had a specific budget to arrange STEM activities, afforded teacher development and managed relevant activities to STEM education such as STEM camp and project contest. Moreover, using individual budget allows the schools to accommodate the students for purchasing the tools and related educational aids and arranged STEM activities such as STEM project

competitions, STEM Camps, and student and teacher training programs. But, in some small scales schools, they didn't have specific budget and the driving plans, the assigned teachers were responsible alone in managing STEM activities. Hence, if there are well supports both in budget and good materials, the development of teachers and students can be resulted effectively including the attitude toward STEM study.

4. Learning Resources

From the budget allocation, the schools have been set the specific budget, invested some of money on the basic structure and material resources including learning materials and technology. For example, STEM education centre in schools were established for just showing the students' productions and forming related activities, while, most of the students still study in the classrooms which were small but arranging STEM education class requires some spaces. Even in some schools, the teachers purchased computers, projectors, or smart board to manage STEM education activities. Thus, the number of these devices was not enough and lacked of maintenance unit to take care of the stated resources. In the classroom, teachers also provided all the material for students, so they were easier to access the learning by using the appropriate material.

Moreover, IPST has provided media and technology through the regional STEM education centers such as I-Robot with the curriculum to accommodate teachers in managing the learning activities. From the interview, the students were interested in the learning activities; however, there are some difficulties for some schools that have too much students per class to participated in the small amount of these educational aids. But, this case of investment, there are only extra-scale schools and STEM centers did that, because they believed that investing in these resources is clearly seen that they can draw students' attentions in learning. Sometime the investment wasn't worth it. For long-term development, schools should concern of investing more on human resources and time management too because, schools lacked of related STEM education professional teachers, then the progress of developing in schools were very slow.

Form the surveying, mostly in the small-scale schools, the only way to arrange the activity was teachers assigned the students to bring the

equipment from home because most of the materials can be found in local, because they don't have enough budgets to purchase the educational aids. teacher also couldn't provide more frequently activities. As the results, learning resources became one of the unfair issue of learning opportunity.

2.2 Teacher development

From the survey, the most important problem on teachers was they didn't have knowledge in content and the methodologies to integrate the four subjects together. In the past, teachers had been through the short training not the full course training, so they did not understand and were not confident when they had to manage the class by themselves, especially in engineering and science subjects which they hadn't learned or had the background before. Likewise, primary schools were unable to supply teachers to lead STEM leaning activities. Consequently, all the responsibilities on STEM lay on one teacher or one department who has been experienced the basic training. Thus, activating STEM activities were not satisfied. It becomes necessary that teachers should be developed and trained appropriately.

1. Teachers development by the agencies

When the teachers were assigned to be STEM teachers, they needed to participate in the training organized by IPST which the main regional lecturers were trained and extended the knowledge to teachers in the sub areas. Most of the contents that used to train are mainly focus on the background knowledge about STEM, ways to manage the learning activities by using 'hand-on activity' which the teachers had actual practice, and writing activity plans. In this occasion, the teachers from different schools had an opportunity to share the ideas and learn together. Additionally, some schools also invited the experts from the university to give the knowledge about STEM classroom management, but it was just a short period course. The purpose of training teacher was let teachers to change and adapt the ways of teaching. Moreover, in this academic year of 2017, Ministry of Education emphasizes to develop the teachers using STEM Online, expecting the better result. So, teacher from schools in the remote area were easily joined the training programs.

However, in school level, there was no follow-up whether teachers imported the policy into classroom or not. Moreover, there was not enough cooperation in managing learning activity as it should be. Besides, the time to

arrange the class was limited; causing STEM learning process was not fully active in all schools.

2. Abroad Teacher Training

From building the connection with the organizations in other countries such as Japan, England, Australia, New Zealand and United State of America, teachers were sent to observe and learn about STEM to improve and be able to use the experiences to manage the STEM education learning activities both in the teaching area and managing area. But going aboard chances were only benefit for some group of teacher. They brought some innovation applied in the classroom, for example students in Phitsanulok provinces learned about the Robot from the teachers who went to Japan, and invented some related items such as cleansing air conditioning machine and cleaning robot.

On contrast, some teachers complained that they couldn't apply anything to the classroom due to the readiness in school, the differences of student's learning ability, and limiting of teacher's ability and knowledge.

2.3 Learning management

1. STEM activity management in schools

Most of the teachers express that STEM innovation advantages the students to have analyzing and observing skills. Most of the teachers' teaching technique was demonstration which supports the students to create a group project based on their interests. The students can access in group communication and teamwork well, as well as, the project based-learning combining with STEM integration precisely reflects that STEM education takes important part in developing both the teachers' teaching technique and the learning process of the students. On students' side, it was found that they acknowledged the existence of STEM education from teachers that it was enhanced their thinking and analyzing skills from operating a group project. Thus, most of the students had good attitudes towards the activities because they can think and practice by themselves and this made STEM differs from other subjects. Whereas, the students were the passive learners who have to follow the orders in other subjects. However, the minority does not agree to have STEM education in class or have bad attitudes since they haven't neither practiced the integrated thinking before nor were able to adjust themselves to the new learning environment and

didn't get used to with the critical thinking teaching style. Therefore, the students had better attitudes towards STEM activities than regular lecture class

2. Curriculum usage

The schools in the project utilized the curriculum which the Committee of Developing STEM Educational Learning Management Curriculum has designed. some schools had managed STEM education into the Learner Development Activity. Teachers drawed out the curriculum and manage the lesson plan, let students to make one project per each semester. From the interview about the teachers' opinions towards the content in the curriculum, it is found that the curriculum is appropriate and relevant to the main content in each grade. Besides, the curriculum is flexible that teachers can adapt the activity and make it more suitable with the local context, so students can learn smoothly and naturally. Moreover, students have better integrative thinking. Previously, STEM was a unit of integration in science, mathematics and technology subjects. Because of the limited of time, excess content in the core curriculum along with the extracurricular activities, the integrative activities were not acceptingly successful. Later, as the Ministry of Education announced the new policy 'Moderate Class, More Knowledge', most of the schools manage that time to arrange the STEM activities. Therefore, there was at least once a week that the students have time to participate in STEM activities. In the early phase, teachers were worried that STEM activities would overtake time of the normal class and cause much work for students. However, when the policy has been promoting, teachers have had more time to manage the learning activities and students have continuity in learning. It can be seen that the former policy can perfectly support latter policy.

3. Teaching and Evaluation

Every school nowadays use the same basic core curriculum. Nonetheless, all subjects have their own subject natures. As a consequence, when providing STEM activities, teachers have to integrate the knowledge from the four stated subjects combining with other teaching techniques such as Problem-Based Learning, Project-Base Learning and Active Learning. Further, the teachers have to explain the related theory, demonstrate and finally having students to practice. They also have to use various kinds and media and materials to maintain the attentions of the class. For evaluation, the pass grade would be

given as an evaluation instead of the GPA. Teachers have to target on the work more than the theories so that students can have good attitudes towards STEM education. Because students can actually take action on learning from the beginning to the end, this made them to be more imaginative, be able to think systematically and work in group. The students in some schools can also adjust the knowledge into their real life. For example, the student in grade 4 shard her experience when she has learned about the unbreakable falling eggs that she used the knowledge to keep the eggs at the house not to break. In addition, the students can invent things to solve the problems such as the bottle clip and the frog catcher. Surprisingly, the students can further develop the knowledge into something better; for example, building on a robot to an automatic A.C. washer.

Conclusion

According to the establishment of ASEAN community on 31th December 2014 has stimulated Thailand to prepare human resources in order to serve the country's development in the future. Unfortunately, the latest score results of PISA and TIMSS tests of Thai students had failed to satisfy the requirements. With the intention of developing science and technology in Thailand, the government assigned the Ministry of Education to announce a policy of making STEM education as a national improvement plan and innovation. The main organization to drive STEM policy is responsible by IPST in which there are the regional STEM centers as the main office for STEM network schools. However, Thailand has been set very clearly and logically of STEM education's policy. Thailand's STEM education could drive in the same practical direction, including driving curriculum usage, and training teachers.

Even though, the driving STEM education policy in northern Thailand is all well-known but according to the individual conditions of each school, the driving process is not successful as expected. The different cooperation from administrators and parents influences STEM policy. The important elements that drive the policy to be highly successful are the operation of the administrators and teachers, budget and technology and the support from parents. Therefore, the condition problems of each school are the significant reasons that STEM education in Thailand cannot be equally developed. Furthermore, the resources in each school are not fairly provided according to the economic and

social status. Thus, the schools which are rich in accommodations especially the STEM center schools will have high achievement and great products. Moreover, the problems and barriers were the directors of some schools hadn't paid much attention towards STEM educational learning management. They saw STEM activities as the burdens for both teachers and students. Also, there were not enough budget and media to reinforce the activities. Teachers had too many duties and some transferred to other schools which caused discontinuous lessons. Moreover, the teachers lacked of proficiency due to being in a learning and improving process. As a result, the teachers could not give academic advises and effective teachings for students. In addition, the students had limited time to do activities since they had to spend most of the time for other subjects.

Suggestion for STEM education in Northern Thailand

1. The Ministry of Education's STEM education was clear but the passing process from PPST. to OBEC was inefficient because of the lack of STEM education professionals in OBEC. The reaction of the policy to perform in OBEC, educational service area and school level was still short of connections. It was found that PPST had itself appointed the working group to work in regional STEM education and in educational service area. Indeed, this issue should be precisely coordinated and clearly understood in the duties and responsibilities. This topic of STEM education should be brought up to the national meeting because it was the problem about using authority of the government sector.

2. The budget to drive the project in school level was surprisingly little. Even though OBEC was the main sector to take care of the project, the budget hadn't been specifically managed. Therefore, OBEC should be the one who fully watched the project and had PPST as the assistant. Moreover, OBEC should coordinate with the university personnel as they can be the academic support for STEM education.

3. The organization of STEM education curriculum should be done according to the context of the each area in Northern Thailand. Since each area had its own identities. Some were famous in tradition and culture, and ancient destinations such as Luke Wit Nam or water wheel in Northern Thailand which was the prototype of Chaipattana Low Speed Surface Aerator, Model RX-2

innovation, used to purify the air in the water and purification and dispose wastewater.

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