Journal of Positive School Psychology
2022, Vol. 6, No. 5, 7099–7109 http://journalppw.com

Innovation Development for Quality Enhancement of Sciences and Mathematics Learners in Secondary Schools under the Office of the Basic Education Commission

Patcharaporn Thamma[1], Wisut Wichitpatcharaporn[2], Sanan Prachongchit[3], Suphot Koedsuwan[4],Achara Niyamabha[5]

[1,2,3,4,5] *Kasetsart University, Thailand.*
[1]*patcharaporn.tham@ku.th, feduwsw@ku.ac.th,* [2]*sananpr@gmail.com,*
[3]*supod123@hotmail.com,* [4]*a.niyamabha@gmail.com*

Abstract

The objectives of this mixed methodology research paper were to 1) study the conceptual framework for quality enhancement of sciences and mathematics learners in secondary schools; 2) develop innovation for quality enhancement of sciences and mathematics learners in secondary schools; and 3) evaluate the developed innovation for quality enhancement of sciences and mathematics learners in secondary schools. The data were collected using a questionnaire with a sample randomly selected from school administrators and heads of the learning subject groups of 239 secondary schools under the Office of the Basic Education Commission; and interviewing five experts. The developed innovation was evaluated by a focus group discussion of 15 experts.

The results of the research were as follows:

1. The conceptual framework for the conceptual framework for quality enhancement of sciences and mathematics learners in secondary schools consisted of eight components: 1) policy and strategic plan, 2) communication, 3) support for the development of the whole system, 4) analysis and a process study, 5) quality outcome analysis with information systems, 6) curriculum development and transformative learning, 7) effective leadership, and 8) quality development network. The quality of learners consisted of: 1) learning skills in science and mathematics, 2) learning achievement of students in learning science and math, and 3) good attitudes towards learning science and mathematics.

2 The developed innovation for quality enhancement of sciences and mathematics in secondary schools composed of: 1) innovation principles which were participatory management principles, principles of emphasis on quality of learners in science, mathematics, and principles of networking; 2) innovation objectives, three aspects of student quality; eight factors of quality enhancement management; 3) factors driving the development of student quality in science and mathematics, five of which were: commitment of school administrators, supervision and following up, participatory quality improvement, teacher motivation, and professional development of teachers.

3. Results of the developed innovation evaluation for quality enhancement of sciences and mathematics learners in secondary schools found to be at the very highly appropriate level.

Keywords— innovation, quality enhancement, secondary school, learner, science and mathematics

INTRODUCTION

According to the nation's Educational Reform Plan, the reform of teaching and learning management should be responded to changes in the 21st century, by which the reform issues included: teacher development on proactive in learning management, of formative achievement evaluation for learner, of

knowledge and subject matter teaching competency, of pedagogy, of instructional media and technologies, on the 21st century skills instruction, and on roles of teachers in the new era (Independent Committee for Educational Reform, 2019). Based on the study of the Ministry of Education policies, in the 2020-2021 fiscal year, emphases were put on developing teachers at all levels to have the necessary skills and knowledge of a professional trainer (train the trainer) and expand the development results through the Human Capital Excellence Center (HCEC), adopting the STEM (science, technology, engineering, mathematics) approach of instruction at the secondary level (Ministry of Education, 2020).

Developing the potential talents in science, mathematics and technology of children and young people is of great importance and necessity because such talents were of vital factors in driving and developing the country forward and increasing long term competitiveness (Porter, 1990). As such, provision of education for science, mathematics and technology talented students in Thailand was one of the goals set by the Office of the National Economic and Social Development Council in 2018. The development goals focusing on increasing the country's potential in various dimensions based on 3 concepts: 1) topping up what had been done in the past; 2) adjusting what are currently doing to pave ways for the future through improvement of the country's such infrastructure as communication and transport network, science, and digital technology; and 3) create new value for what to be done in the future. Adjusting what have been doing at present are of challenging roles of school administrators as driving forces toward the goals. Although a variety of curricular satisfying individual differences responsive to students needs and capability at the high school level, one of which is science and mathematics study route, the top preference one, are offered, a question is how special classes for science and mathematics talented students be effectively implemented.

Currently, a number of secondary schools in Thailand are promoting and developing students with special abilities. These so call science prototype secondary schools were, for example, Mahidol Wittayanusorn School; Kamnoetvidya Science Academy, and of Princess Chulabhorn Science High School, Chonburi Province. Achievement on science and mathematics subjects of their students have been much higher than those of regular secondary schools. According to the National Basic Education Test (O-NET) of the 2019 academic year, the percentage scores on science and mathematics subjects of students in these science prototype secondary schools were 79.67 and 95.66, 75.25 and 92.85, and 57.18 and 79.77, respectively; while those of the national average scores was only 29.20 and 24.41.

Such science prototype secondary schools cannot be adopted across the country since secondary schools in general have limited allocation for personnel, resources, and student selection. Another alternative for increasing the number of potential talents in science and mathematics of secondary school students has been carried out in terms of special science classrooms in extra-large size secondary schools. To be more effective, these special science classrooms need appropriate innovations to extend their possible capacity of science and mathematics instruction.

From such importance, the researcher, therefore, aimed to develop innovations enhancing the quality of sciences and mathematics learners with the view that the findings of this research will be beneficial to sciences and mathematics instruction as well as raising awareness among administrators, teachers, and other stakeholders that it is important to develop the quality of learners in science and mathematics.

Research Objectives

1. To study the conceptual framework for enhancing the quality of learners in science and mathematics in secondary schools under the Office of the Basic Education Commission.
2. To develop innovations enhancing the quality of students in science and mathematics

in secondary schools under the Office of the Basic Education Commission.

3. To evaluate the developed innovations enhancing the quality of science and mathematics learners in secondary schools under the Office of the Basic Education Commission.

Research Methodology

This research was carried out in three phases.

Phase 1: Studying conceptual frameworks of enhancing quality of science and mathematics learners in secondary schools which was done in two sequences.

1.1 Reviewing and synthesizing related literature, both domestically and internationally, on concepts, theories relevant to quality enhancement. Eight components quality enhancement plus three aspects of learner quality framework in line with the criteria of quality schools, prescribed by the Promotion of Science and Technology Institution. were formulated. The tool used was a model for document analysis created by the researcher and the content analysis.

1.2 Interviewing five qualified experts on the topic of quality enhancement. The tool used for data collection was a semi-structured interview. The main focus of the interview was on how to drive the quality of learners in science and mathematics in secondary schools. Eight components of quality enhancement were: 1) policy and strategic plan, 2) communication, 3) support for the whole system development, 4) process analysis and study, 5) analysis of quality results by information systems, 6) curriculum development and transformative learning, 7) effective leadership, and 8) quality development networks.

Phase 2: Developing innovations for quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission. This was also done in two sequences.

2.1 Studying existing and desirable innovations for enhancing quality of science and math learners in secondary schools. The tool used was a questionnaire. The population consisted of school administrators, heads of science and technology learning subjects, and heads of math learning subjects of 239 secondary schools. The tool was a questionnaire with content validity, checked by five experts, in terms of IOC (index of item-objective congruence) which was between 0.60-1.0 and reliability of the questionnaire 0.95.

A sample of 148 schools, the size with 95% confidence level, was randomly selected by means of multistage sampling technique. Three informants per school, totaling 444 by using a multistage randomization method. The region in Thailand was a first-stage sample unit. The sample was extra-large schools under the Office of the Basic Education Commission, totaling 148 schools. Data was analyzed by means of mean, standard deviation, and Priority Needs Index Modified ($PNI_{Modified}$).

2.2 Focus group discussion of nine qualified experts, purposively: one science learner promotion policy strategy, one policy expert, two university science lecturers, one representative from the Institute for the Promotion of Teaching Science and Technology (IPST), three school administrators, and one science teacher. The data were analyzed by content analysis.

Phase 3: Evaluating the developed innovation for quality enhancement of sciences and mathematics learners in secondary schools by 15 experts purposely selected from administrators of exceptional extra-large secondary schools. The tool was an appropriateness and feasibility assessment form, from which the data were content analysis.

Results

The findings of innovation development for quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission can be summarized as follows:

Objective 1: Conceptual framework

Based on reviews of related documents and research, interviews, and questionnaire responses, the developed a conceptual framework for quality enhancement consisting of eight components: 1) policy and strategic

plan, 2) communication, 3) support for the whole system development, 4) process analysis and study, 5) analysis of quality results using information systems, 6) curriculum development and transformative learning, 7) effective leadership, and 8) quality development networks. Three aspects of learner quality were: 1) learning skills in science and mathematics, 2) students' achievement in learning science and mathematics, and 3) good attitudes towards learning science and mathematics.

Objective 2: Innovation development

The existing and desirable quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission were analyzed in terms of mean ($\bar{x}$), standard deviation (S.D.), and Priority Need Index (PNI). The overall result of existing and desirable quality enhancement of science\ and mathematics learners was shown in Table 1.

Table 1 Overall results of existing and desirable quality enhancement of sciences and mathematics learners

Rank	quality enhancement	Existing		Desirable		$PNI_{Modified}$
		$\bar{x}$	S.D.	$\bar{x}$	S.D.	
1	Communication	3.89	0.85	4.61	0.55	0.19
2	Analysis of quality results by information systems	3.82	0.79	4.55	0.78	0.19
3	Support for the whole system development	3.94	0.79	4.62	0.71	0.17
4	Quality development networks	3.91	0.70	4.59	0.64	0.17
5	Process analysis and study	4.00	0.71	4.62	0.61	0.16
6	Policy and strategic plan	4.05	0.78	4.60	0.53	0.14
7	Curriculum development and Transformative learning	4.19	0.70	4.75	0.50	0.14
8	Effective leadership	4.08	0.87	4.60	0.72	0.13
	Total	**3.99**	**0.77**	**4.62**	**0.67**	**0.16**

From Table 1, it was found that the overall level of existing quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission was at the high level ($\bar{x}$=3.99). The aspect ranked at the top was that of curriculum development and transformative learning ($\bar{x}$=4.19), followed by effective leadership ($\bar{x}$=4.08), while the lowest ranking was quality of results analysis by information system ($\bar{x}$=3.82).

The overall level of desirable quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission was at the very high level ($\bar{x}$=4.62). The aspect ranked at the top was that of curriculum development and transformative learning had the highest level of opinion ($\bar{x}$=4.75), followed by support for both system development and the aspect of process analysis and study having the same mean with the highest level of opinion (x=4.62), while the lowest ranking was the quality analysis by information system which had the highest level of opinion ($\bar{x}$=4.55).

As of the Priority Need Index ($PNI_{Priority}$), the overall index of quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission was 0.16. The aspect ranked at the top was that of communication and quality analysis by information systems ($PNI_{Priority}$=0.19), followed by support for the whole system development ($PNI_{Priority}$=0.17), while the lowest ranking was effective leadership ($PNI_{Priority}$=0.13).

2.2 The results of innovation development by focus group discussion experts on quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission was shown in Figure 1.

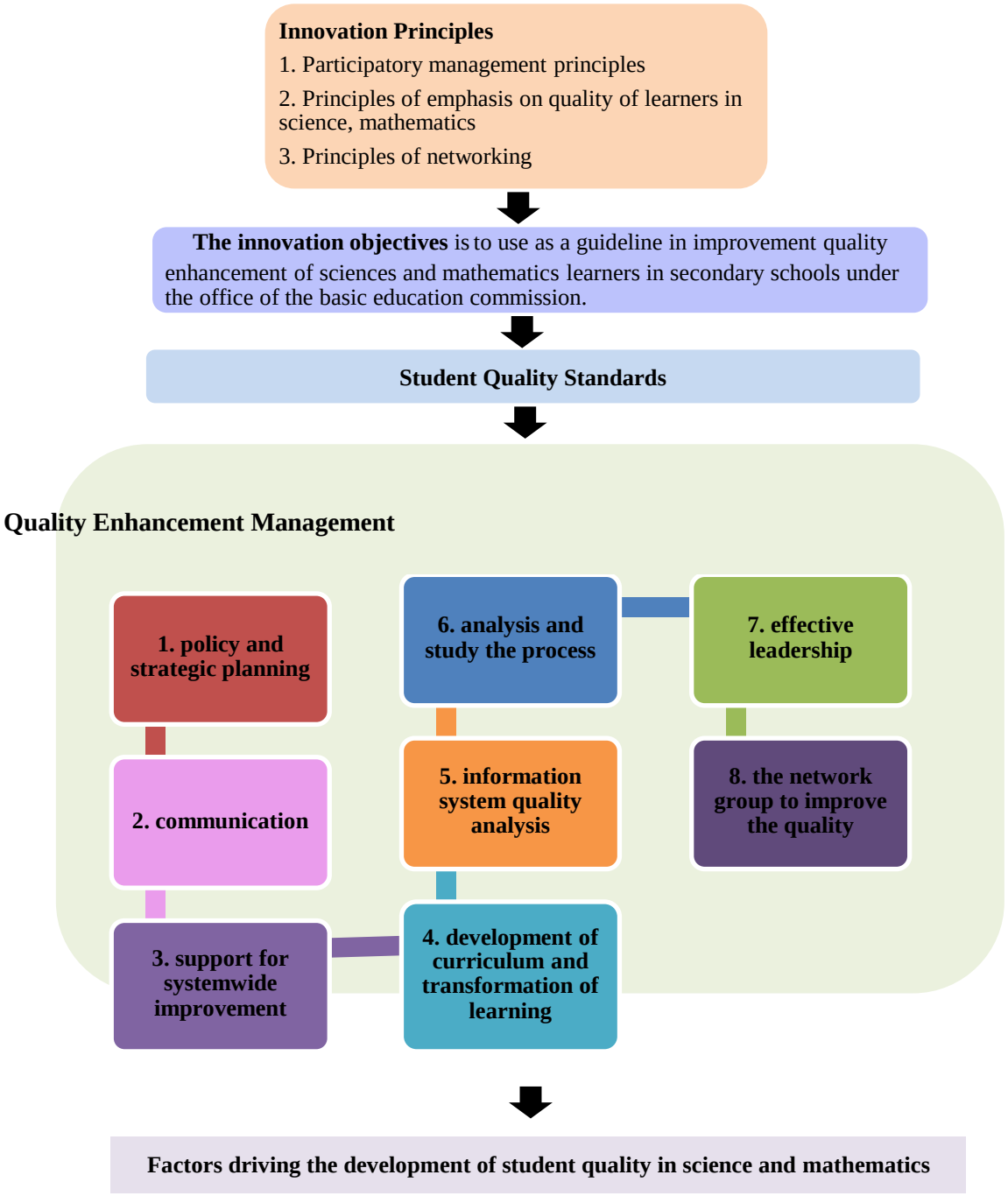

Figure 1 Innovation for quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission.

The details of the innovation for quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission consisted of eight components as follows:

Component 1: Policy and strategic plan

Schools should have a clear written policy on the development of science and mathematics learners by formulating strategic plans that systematically promote the quality of science and mathematics learners. Priority was placed in the process of formulating policies and strategic plans that were defined and consistent with IPST's learner quality standards and stems from the participation of stakeholders.

Component 2: Communication

Schools should clearly articulate the policies and program objectives in the science and mathematics strategic plan, as well as

communicate strategic information to stakeholders through a variety of channels.

Component 3: Support for the whole system development

Schools should allocate resources efficiently to support the implementation of strategic plans, encourage staff to use resources effectively. Resources for quality teaching should be provided including libraries, science laboratories, Quality modern IT facilities.

Component 4: Process analysis and study

The school should analyze the quality development process and continually improve the operational quality by clearly analyzing and defining the roles and duties of personnel in each process, supervise and monitor the work in a systematic manner aiming at improving the quality of students in science and mathematics.

Component 5: Analysis of quality results by information systems

The school should develop a modern and easy to use information system on improving the quality of learners in science and mathematics that is modern, easy to use. Processing times should be short and performance be displayed on the web page. There should be an analysis of learner quality, collecting system processing data according to user needs. There should be an easy-to-use data warehouse for monitoring the process of organizing computer equipment and facilitating access to information systems. A system for reporting information should be clear, easy to understand, complete, accurate, and secure is developed, and the information is used for decision-making to improve quality.

Component 6: Curriculum development and transformative learning

The school should continually improve its curriculum by designing extra-curricular activities that facilitate the development of learners' characteristics and attitudes towards learning science, mathematics. There should be a promotion of teaching-learning management, emphasizing proactive learning, encouraging teachers to adjust teaching-learning management to be in line with the changes in the present era, raising awareness that all stakeholders are responsible for learners' learning. There should be measurements and assessments consistent with the curriculum and students' academic achievements are used as inputs for quality improvement according to the standards of learners in science and mathematics.

Component 7: Effective leadership

Administrators should have vision, foresight, focus on teaching, continuous human resource development, good relationships, and be role models in the practice, focusing on learners' learning. The administration should be decentralized, and there should be a continuous and sustainable improvement in the quality of students in science and mathematics.

Component 8: Quality development networks

The school should provide opportunities for parents, communities, society to participate in raising the quality of learners, building clear relationships with stakeholders, and building cooperation in working together to create a clear understanding of their roles and responsibilities of those involved stakeholder feedback is used to improve learner quality by utilizing the recommendations and stakeholder needs as inputs in curriculum design and development. Networks should be created by allowing personnel or external agencies to participate in the organization for the benefit of the public in enhancing the quality of learners.

Factors driving the development of science and math learners' quality consists of five factors as follows:

1. **Commitment of the school administrators**: The administrators are committed to improving the quality of learners in science and mathematics by stimulating and motivating teachers and all related personnel to cooperate in continually improving learner quality.
2. **Supervision and Monitoring of Progress**: The administrators have to supervise and monitor the progress of operations to continuously enhance the quality of science and mathematics learners.
3. **Contributions to Quality Improvement**: Administrators allow teachers and personnel, parents, students and communities to participate in decision-making, systematic development and problem solving. The organization is

managed with flexibility with freedom to plan, implement, and encourage stakeholders to participate in educational administration.

4. **Motivating:** Administrators build morale through positive reinforcement and reward teachers who can develop the quality of science and math learners to meet standards.

5. **Academic Teacher Development**: Promote learning of science and mathematics and participate in the learner development process. Administrators play a role as a coach to organize a course on teacher development. Find a platform for teachers to develop themselves and learners of science, mathematics, both locally and internationally.

Objective 3 Evaluation of the developed innovation

Results of evaluating the developed innovation for quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission by 15 experts is shown in Table 2.

Table 2 Summary results of innovation evaluation

No.	Items	Appropriateness level	
		$\bar{x}$	Level
1	Innovative picture	4.70	Very High
2	Principle of innovation		
	2.1 Participative management	4.50	Very High
	2.2 Principles of emphasizing quality of learners in science, mathematics	4.70	Very High
	2.3 Networking	4.80	Very High
3	Innovation purpose	4.60	Very High
4	Student quality standards	4.70	Very High
5	Management for Quality Enhancement		
	5.1 Policy and strategic plan	4.50	Very High
	5.2 Communication	4.50	Very High
	5.3 Support for the whole system development	4.50	Very High
	5.4 Process analysis and study	4.60	Very High
	5.5 Analysis of quality results by information systems	4.60	Very High
	5.6 Curriculum development and transformative learning	4.60	Very High
	5.7 Effective leadership	4.70	Very High
	5.8 Quality development networks	4.60	Very High
6	Factors that drive the development of science and math learners' quality consists of 5 factors		
	6.1 Commitment of the school administrators	4.70	Very High
	6.2 Supervision and Monitoring of Progress	4.40	High
	6.3 Contributions to Quality Improvement	4.40	High
	6.4 Motivating	4.80	Very High
	6.5 Academic Teacher Development	4.70	Very High
	Total	**4.61**	**Very High**

From the Table 2, evaluation of the developed innovation for quality enhancement of sciences and mathematics learners in secondary schools under the Office of the Basic Education Commission by 15 experts, it was found that the overall innovation for quality enhancement of sciences and mathematics learners in secondary schools was at the very high level ($\bar{x}$=4.61). The aspect ranked at the top was that of the principle of networking, and that of the driving factor for the development of the quality of science and mathematics learners on motivation had the highest evaluation (($\bar{x}$ = 4.80), while the lowest ranking was that of the supervision and monitoring of progress and participation in quality improvement ($\bar{x}$=4.40).

Discussions

1. For the research objective 1, conceptual framework, it was found that the conceptual framework for enhancing the quality of science and mathematics learners in secondary schools under the Office of the Basic Education Commission consisted of eight components: 1) policy and strategic plan, 2) communication, 3) support for the whole system development, 4) process analysis and study, 5) analysis of quality results by information systems, 6) curriculum development and transformative learning, 7) effective leadership, and 8) quality development networks. These represent the process of school administration, quality improvement, quality upgrading processes or standardized quality assurance, especially in the field of curriculum development and transformative learning that directly affect the quality of learners and contribute to schools, administrators who will drive the quality of science and mathematics learners in secondary schools by having to complete all eight components.

The conceptual framework for student quality consisted of: 1) learning skills in science and mathematics, 2) students' achievement in learning science and mathematics, and 3) good attitudes towards learning science and mathematics. They were consistent with standards for schools on the management of education for the talented people, set by the Office of the Education Council (2011 cited in Pattrawiwat, 2016) to be of four areas: 1) management; 2) talented students search and selection process; 3) learning management, and 4) emotional and social support. Most of students in regular secondary school classrooms are unable to achieve these standards, special science classrooms are thus normally organized in extra-large size schools to accommodate science and mathematics talented students. Management of such special classrooms need sufficient budget, normally allocated from school-based earned revenue, for flexibility. Talented students for these special science classrooms, selected through competitive examinations, need a carefully formulated specific process of searching and selection. Teaching management should follow STEAM approach as suggested by Poomsoong (2021).

2. For the research objective 2, innovation development, results of the analysis of innovation development to enhance the quality of science and mathematics learners in secondary schools, revealed that the aspect of curriculum development and the innovative learning was ranked at the top on both existing and desirable ones. This may be because schools have the main goal of developing learners. Projects focused on science and mathematics in secondary schools, such as special science and mathematics classrooms are appropriate measures enabling students to achieve science and mathematics learning more than the regular classrooms. As for the priority need index ($PNI_{Modifidede}$), the aspect of communication and quality results analysis with information systems was ranked the highest. This may be because secondary schools under the Office of the Basic Education Commission need to improve the quality of learners in all aspects, especially administrative communication. The finding support that of Phabua (2021) who studied the communication skill of the school administrator which affect the teacher performance motivation in international standard school under the Office of the Secondary Educational Service Area 3, Phra Nakhon Si Ayutthaya Province, and found that the communication skills of school administrators in four areas, namely speaking, writing, gestures, and technological media influenced the teachers' motivation to work. Nowadays, there are a variety of communication channels, including online channels, using various information to make decisions in enhancing the quality of learners, therefore, quality results must be analyzed with ready to use modern information systems.

Innovation enhancing quality of science and math learners in secondary schools with management to enhance the quality of eight components: 1) policy and strategic plan, 2) communication, 3) support for the whole system development, 4) process analysis and study, 5) analysis of quality results by

information systems, 6) curriculum development and transformative learning, 7) effective leadership, and 8) quality development networks. The principles of innovation include: principles of participatory management, principles of emphasis on student quality in science and mathematics, and principles of networking, must be carefully studied before implementing the innovations. Three student quality standards in terms of factors driving the quality development of students in science and mathematics: commitment of the school administrators, supervision and following up, participation in quality improvement, motivation, and teacher academic development, must also be considered.

3. For the research objective 3, evaluation of the developed innovation, administrators of 15 schools rated the overall innovation suitability at the very high level. The aspect ranked at the top was that of the principle of networking, and that of the driving factor for the development of the quality of science and mathematics learners on motivation had the highest evaluation, while the lowest ranking was that of the supervision and monitoring of progress and participation in quality improvement. This may be because the school administrators perceived that the innovations enhancing quality of science and mathematics learners in secondary schools can serve as a guideline for developing science and math learners and apply them to school contexts. This corresponds the research of Thummatassananon (2019), a study of the operational network administration strategies to develop the small schools under the Office of the Basic Education Commission, and found that there were five components of the management of cooperation networks for the development of small schools: 1) network membership assignment 2) participation in network operations 3) communication and interaction 4) leadership of network coordinators 5) assessment and job improvement. The results of the suitability assessment were at a high level which can be used as a guideline for building a quality network of schools under the Office of the Basic Education Commission, leading to improving quality of education.

Conclusion

This study of innovation development for quality enhancement of science and mathematics learners in secondary schools under the Office of the Basic Education Commission revealed eight components of quality enhancement: 1) policy and strategic plan, 2) communication, 3) support for the whole system development, 4) process analysis and study, 5) analysis of quality results by information systems, 6) curriculum development and transformative learning, 7) effective leadership, and 8) quality development networks. The quality of learners in three aspects are 1) learning skills in science and mathematics, 2) students' achievement in learning science and mathematics, and 3) good attitudes towards learning science and mathematics. Three principles of innovation: participatory management principles; principles of emphasis on quality of learners in science, mathematics, and principles of networking. The developed innovation composed of one innovation objective, three student quality standards, eight components of quality management, and five factors driving the development of student quality in science and mathematics. Evaluation of the developed innovation by 15 experts found that the overall suitability of innovation was at the very high level.

The aspect ranked at the top was that of the principle of networking, and that of the driving factor for the development of the quality of science and mathematics learners on motivation had the highest evaluation, while the lowest ranking was that of the supervision and monitoring of progress and participation in quality improvement.

Recommendations

The findings could lead to the following recommendations.

1. Recommendations from research results

1.1 Management should be involved in all eight components of the quality upgrading process. There should be more studies on the elements of quality enhancement in defining the roles and duties of teachers as teachers are the transferors and close to the learners and should increase learner quality indicators by evaluating essential key competencies and using international measurement criteria.

1.2 By analyzing innovations from research findings, designing and experimenting with their own departments in the appropriate context, administrators must implement and drive innovation under five factors driving the quality improvement of science-mathematics learners or additions according to the administrative guidelines of the educational institution context and used to formulate a policy to enhance the quality of learners in science-mathematics in secondary schools under the focus on the quality of learners

1.3 From the results of the evaluation of innovations to enhance the quality of science-mathematics learners in secondary schools under the Office of the Basic Education Commission, it was found that the administrators used them to effectively enhance the quality of learners with a higher level of appropriateness. Therefore, innovation manuals and application should be added to achieve a clear understanding of how to use them for administrators to have a common understanding of how to implement innovations and implement them for students and to be a model and to expand the results in secondary schools under the Office of the Basic Education Commission.

2. Recommendations for further studies

2.1 From the research, it was found that the quality enhancement of communication and quality analysis by information systems had the highest priority need index. If further research is needed, it should study the development of information systems in educational institutions that affect the quality of education and should study the communication via online channels of administrators that affect teacher performance and learner quality.

2.2 From the research, it was found that an innovation to enhance the quality of learners in science and mathematics in secondary schools under the Office of the Basic Education Commission consists of 8 components of educational institutions development process, 3 aspects of learner quality. If further research is needed, a causal model of factors affecting learner quality in problem-solving skills, creativity, and high-thinking should be developed.

References

1. ASEAN University Network. 2015. Guide to AUN-QA Assessment at Program Level Version 3.0.
2. Boonprawes, Supasiri. 2017. **Innovative Quality Management System of Higher Education Institutions Based on International Quality Criteria.** Doctoral Dissertation, Chulalongkorn University.
3. Chittep, Phipatpong. 2021. The Development of Social Innovation Creative Ability in Geography Using Design Thinking Learning Process for Mathayom-Five Students. **Journal of Roi Kaensarn Academy.** 6(10) October 2021.
4. Independent Committee for Educational Reform, 2019. **The Nation's Educational Reform Plan.** (Online). https://lamphuncity.go.th/wp-content/uploads/2020/05/.pdf. 1 April 2021
5. Institute for the Promotion of Teaching Science and Technology. 2021. **Quality School of Science, Mathematics and Technology according to IPST standards.** (Online) Retrieved from http://pd.ipst.ac.th. March 30, 2021.
6. Ministry of Education. 2020. **Announcement of the Ministry of Education on Policy and Focus of the Ministry of Education, fiscal year 2021 (Online).** Retrieved from https://www.moe.go.th/. March 10, 2021.
7. National Institute of Educational Testing Service (Public Organization) . 2020.

Results of basic national educational testing (O-NET) of Mattayom Suksa 6 students (Online) Retrieved from https://www.niets.or.th/. 27 April 2021

8. National Institute of Educational Testing Service (Public Organization). 2021. **Results of basic national educational testing (O-NET) of Mattayom Suksa 6 students** (Online) Retrieved from https://www.niets.or.th/. 27 April 2021.
9. Office of the Education Council. 2011. **Standards for schools in the management of education for people with special abilities.**
10. Office of the Education Council. 2019. **National Education Reform Plan.** (Online) Retrieved from https://lamphuncity.go.th/wp-content/uploads/2020/05/National Reform Plan in Education.pdf. April 1, 2021.
11. Office of the National Economic and Social Development Council. 2018. **National strategy on building competitiveness.**
12. Pattrawiwat, Kanchana. 2016. **Guideline Development of Quality Gifted Education in Science, Mathematics, and Technology by Using the Application of Futures Research.** Bangkok: Behavioral Science Research Institute, Srinakharinwirot University.
13. Phabua, Teerawee. 2021. Communication Skill of the School Administrator which Affect the Teacher Performance Motivation in International Standard School under the Office of the Secondary Educational Service Area 3, Phra Nakhon Si Ayutthaya Province. Journal of the Periscope Education. **Journal of the Periscope Education**, 8(1) (January-April) 2021.
14. Poomsoong, Pavarisorn. 2021. **Development Design Thinking of Mathayomsuksa 4 Students by Using STEAM Education.** Master's Degree Thesis, Mahasarakham University.
15. Porter, M.E. 1990. The Competitive Advantage of Nations. Competitive Intelligence Review, 1, 14.
16. Pungbangkradee, Shunnawat. 2021. **Development of Primary School Academic Management Innovation based on the concept of Collaborative Evaluation and STEM Education Goals.** Doctoral Dissertation, Chulalongkorn University.
17. Thummatassananon, Sutum. 2019. The Operational Network Administration Strategies to Develop the Small Schools under the Office of the Basic Education Commission. **Journal of Education Burapha University,** 30(3).
18. Yosrungroch, Watcharin. 2017. “Actors Affecting the Quality of Students of the Border Patrol Police Schools
19. under Border Patrol Police Sub–Division 33” **Journal of Phikanatesan**. 13(1) January - June 2017.