Inquiry-based Learning in LSSH:

Implementation and Impacts of the School-based Curriculum

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Abstract

Established in 2000, Taipei Municipal Lishan High School (LSSH) is famous for its unique inquiry-based learning program imbedded in the school-based curriculum. Although LSSH has built a good reputation for its efforts in science education over years, the school never stops pursuing further opportunities to make it a better place to promote inquiry ability, critical thinking, team working ability, and problem-solving skills in the students. The belief motivated LSSH to grasp the chance of taking part in "HIGHSCOPE Initiative," an unprecedented research-based program provided by National Science Council (NSC) for high schools in 2006. It was when LSSH started to refine the inquiry-oriented, school-based curriculum. With the efforts of the participant teachers and administrators, the curriculum framework has become more systematic. Additionally, courses which emphasize the importance of inquiry-based learning and hands-on experiences have been designed, tested and evaluated. The outcomes have helped LSSH win a lot more recognition and support. Meanwhile, the school has received a lot of visitors who come to find out how inquiry-based learning is implemented in the school-based curriculum. Therefore, this paper means to present the curriculum development process in a qualitative manner. It starts with an overall introduction of the school-based curriculum, including the objectives, the framework and development stages. The second section shows how inquiry-based courses were designed, tried and evaluated by the professional learning communities in HIGHSCOPE. The last part of the paper reflects on the process. By sharing the achievements, impacts and reflection, LSSH expects that when looking for strategies for innovative practice such as inquiry-based learning, other schools would find LSSH experiences useful and transferrable.

Key words: school-based curriculum, inquiry-based learning, curriculum development

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I. Introduction: Background Information

Taipei Municipal Lishan High School (LSSH) is located in NeiHu, a suburban district of Taipei in a tranquil valley overseen by beautiful hills. Established in 2000, LSSH has been characterized by its "Science First" approach in Taiwan, which offers a specialized environment devoted to nurturing pupils with talents in math and science. However, LSSH also expands beyond those fields to ensure a well-rounded education in arts and social studies. In pursuing its goals, LSSH stresses the following criteria: First, we expect our faculty to work as a team of professionals that run efficiently with high rapport and morale. In addition, though science is the basis of our system, we expect to develop students' character, enhance their learning, and help them think critically along with a focus on the art of how to work with one another. Most of all, in pursuit of excellence and innovation, the importance of global connection is highly emphasized. With all efforts, the ultimate goal for LSSH is to become the best science-based, internationalized high school in Taiwan.

Like most Asian countries where teaching and learning are traditionally test- and product-oriented, LSSH is faced with a lot of challenges when it comes to innovative practices. Nevertheless, LSSH persists for the following reasons. First of all, in this fast-paced, ever-changing digital age, it is globally recognized that knowledge-based instruction is definitely not sufficient to prepare our students for the future. Rather, it is about the ability to select, analyze, and synthesize information critically. In other words, it is about learning how to learn. Secondly, there is a more prevalent idea that collaboration outweighs competition in the modern world, so schools should provide opportunities for students to learn how to work with one another. Third, the never-ending, emerging Information Communication Technology has flattened the world. In dealing with increasingly complicated interpersonal relationship, more and more of which now takes place in the virtual social networks, students should know how to make use of new collaborative tools as well.

Based on the belief that education is beyond knowledge learning or test preparation, LSSH has made a lot of efforts to keep and refine a school-based curriculum, which aims to promote "learning for the future." The inquiry-based and competency-based curriculum is expected to transform learning habits to develop 21st century skills highlighted by a research[1] conducted by Microsoft Partners in Learning (PiL): (1) Collaboration, (2) Knowledge building, (3) ICT use, (4) Problem solving and innovation and (5)Self-regulation. This paper would present how LSSH develops and implements the school-based curriculum as well as inquiry-based course modules. It is our hope that anyone who is interested in the implementation of inquiry-based learning would find LSSH experiences valuable and transferrable.

[1] Source: Innovative Teaching and Learning Research (Microsoft Partners in Learning) November 2010

II. School-based Curriculum in LSSH

A. Curriculum Objectives

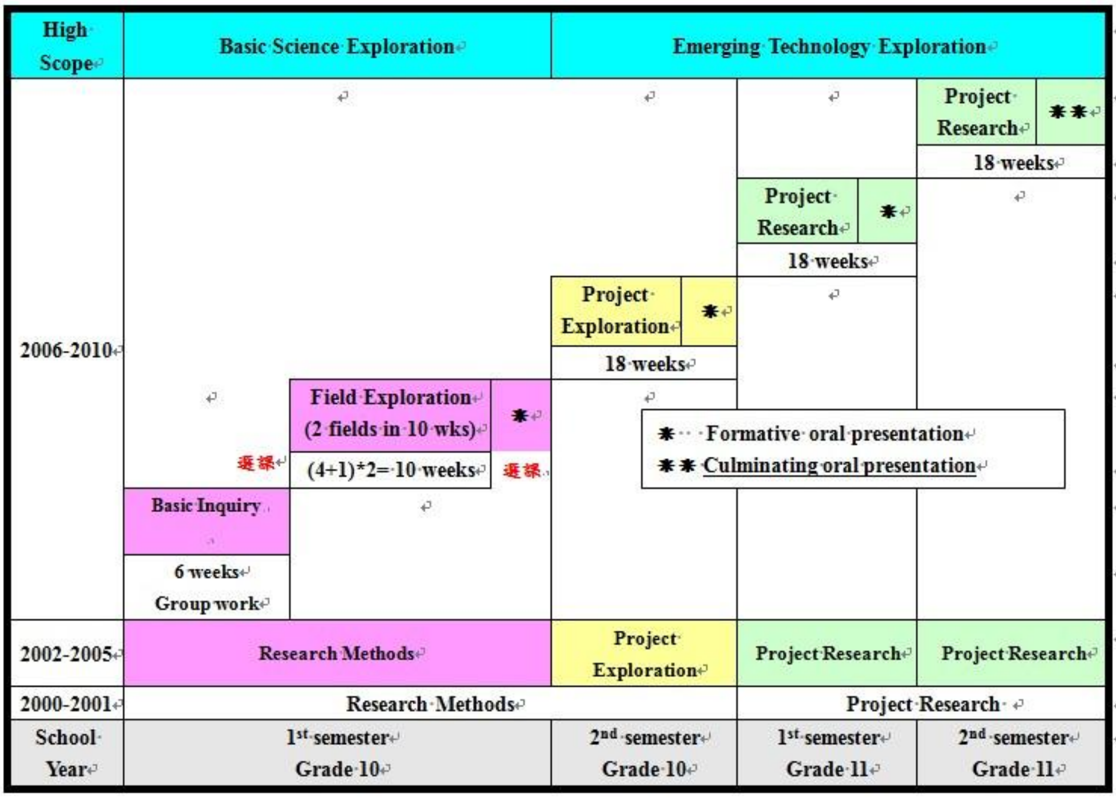
The school-based curriculum in LSSH is composed of two major phases: “Research Methods” in Grade 10 and “Project Research” in Grade 11. Both are required courses but leave room for students to select the field based on their interest and aptitude. “Research Methods” has three stages: “Basic Inquiry,” “Field Exploration” and “Project Exploration.” The one-year “Project Research” requires 11th graders to focus on a chosen project in areas such as Physics, Math, Chemistry, Biology, English, Chinese, Geography, and so on. A summary of the purposes of each stage is outlined as follows:

Table 1: Goals and Objectives of Different Stages in LSSH School-based Curriculum

<table>
<tr><th colspan="2">Phases of School-based Curriculum</th><th>Goals and Objectives</th></tr>
<tr><td rowspan="3">Research Methods
(2 semesters)</td><td>Basic Inquiry
(6 weeks)</td><td>Students are expected to learn “What is Research” by experiencing the basic procedure of inquiry skills and problem solving.</td></tr>
<tr><td>Field Exploration
(10 weeks)</td><td>Through “Learning by Doing,” students are given opportunities to explore different fields/subjects. This helps them find out their interest and potential as well as promote further inquiry skills.</td></tr>
<tr><td>Project Exploration
(1 semester)</td><td rowspan="2">Choosing a field based on the research interest, students are facilitated by the teachers to learn
1. how to explore the problems,
2. how to form a research topic,
3. how to design a research plan,
4. how to conduct experiments,
5. how to collect and analyze data,
6. how to present the findings in written and oral forms
In the process, the students strengthen their reading and writing ability, ICT literacy and oral skills. By accomplishing the tasks and solving the problem in a project, students are expected to become more observant, to think critically and to be collaborative.</td></tr>
<tr><td colspan="2">Project Research (2 semesters)</td></tr>
</table>

B. Framework and Implementation Stages

Unlike most of the schools in Taiwan which struggle to shape and develop a school-based curriculum, the one in LSSH was imbedded from the start. The curriculum was established on researches and it followed the suggestions from a group of curriculum experts. It has three underlying concepts: (1) it should involve a variety of subjects so as to cater to learners with different aptitudes and interests; (2) the curriculum design should be progressive and systematic, which allows learners to explore first and focus later to advance learning in the field they choose; (3) the curriculum implementation should be able to be transferred to every high school in Taiwan. Since 2000, the curriculum has gone through different stages. The changes of curriculum framework are illustrated in Graphic 1 below:



Graphic 1: Changes of School-based Curriculum Framework

1. School Year 2000-2001

During the initial years, the curriculum was divided into two parts: "Research Methods" for one year and "Project Research" for another. While all students were required to take courses from the school-based curriculum, the choices were limited to science and math only. A major challenge emerged since not all students were science or math-oriented. Many felt frustrated in the process when they were forced to take on scientific research. Some changes needed to be made so as to meet the need of the students without losing the goals and objectives of the curriculum.

2. School Year 2002-2005

At this stage, “Research Methods” was reduced to one semester while a transitional phase “Field Exploration” was added, which gave students more time to explore the field they chose before they decided their research topic. To meet different students’ needs, other subjects such as Art and PE were included in the framework. Later, to strike a balance between science and humanity and to provide more choices, Chinese, English and social studies were added to the math and science subjects. In the end of school year 2005, a list of 11 fields (Math, Physics, Chemistry, Earth Science, Biology, Computer, Life technology, English, Chinese, Civic studies) was confirmed and would be included in the curricular framework in 2006.

3. **School Year 2006-present**

In 2006, National Science Council started an unprecedented research-based program, “Highscope Initiative,” for senior high schools in Taiwan. LSSH became part of the four-year program with her innovative project named “GREEN • HANDS-ON • MOBILE,” whose main goals are to polish the framework of the school-based curriculum, develop feasible and transferable inquiry-based course modules, promote teacher professional development and attain the goal of the school-based curriculum. At this stage, we change the curricular structure, encourage teachers to develop competency-based courses and support continuous teacher growth.

With the efforts of the participant teachers and administrators, the curriculum framework has become more systematic over time. Courses featuring inquiry-based learning and hands-on experiences have been designed, tested and evaluated. The impacts will be introduced later.

C. Characteristics of LSSH School-based Curriculum

1. Systematic development

As explained in the earlier section, the implementation stages are evolving into a more systematic structure. The following strategies are taken to make sure the success of the practice.

- To make all participants understand the system better, two sessions of course orientations are held for teachers and students respectively in the beginning of each school year. An implementation manual is distributed to them at the same time.
- Necessary hardware and software are purchased with a view to facilitating teaching and learning. The distribution of the resources are carefully planned and monitored.

2. Whole-school participation

In many local high schools, courses like “Research Methods” and “Project Research” are tailored for a small group of elite students. In LSSH, it is a whole-school exercise, which involves about 600 students, 30 teachers from 11 subjects each year. Every student is obliged to take the course for 2 years. In the process, they are guided to learn basic ideas about researches in the beginning, explore the fields that interest them and decide their research topic and then work on it collaboratively. They have to give formative presentations in different stages and a culminating performance in the very end of the learning journey to showcase their findings and achievements.

3. Strong PD support

Our faculty members, over 90% of whom are masters, are a group of young, energetic professionals who come from diverse educational and professional backgrounds. In the school-based curriculum, when students carry on their research individually or in groups, they require a lot of time and guidance from the teachers. Working alone is never easy, the teachers recognize, and teamwork is a must. To meet teachers' needs of growth, professional development programs are integrated systematically. Both subject teachers and project participants are given certain time slot at school to take part in PD programs.

4. Supported by all stakeholders

In the first years, our parents found it questionable when they saw their children spent so much time on project learning. They doubted, "Isn't it distracting them from academic learning? Will it affect the exam results?" The staff once even had a debate over whether it was worthwhile to insist on implementing the curriculum. However, the final consensus was that working on projects itself is a process of learning how to learn. With a problem to solve or a project to complete, students are expected to shoulder the learning responsibility with teachers as facilitators. They are offered opportunities to cultivate competencies that cannot be reached in a traditional teacher-centered classroom. Therefore, no matter how, the school should keep the curriculum and make it better.

And so we did. Year by year, students' performances in college entrance exams have helped present powerful evidence and persuasion. The testimonies from our alumni and their parents firmly confirm the value of the courses. It also helps when more and more universities come to recognize the distinguished abilities of LSSH graduates. Now, the school-based curriculum has become LSSH's central feature and hallmark. In recent years, more and more students are drawn to LSSH because of the unique curriculum design with their parents' support.

III. Developing Inquiry-based Courses

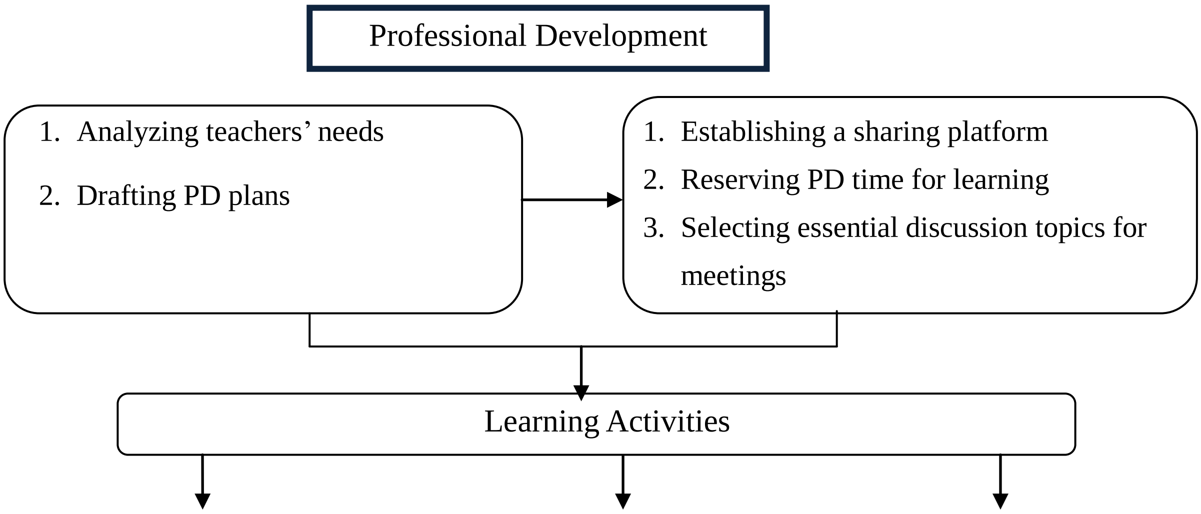
A. Course Development

1. Difficulties and Strategies

Different from regular courses that follow national standards and textbook topics, the school-based curriculum demands teachers develop contents, monitor schedules and design assessments that fit the criteria of inquiry-based learning. It was not a smooth route for teachers, to be sure, because little attention is paid to this aspect in any teacher training program. Almost all the teachers that take part in the school-based curriculum express a strong need for professional support. It was not easy to attain with scarce resources at the initial stage. Luckily, grabbing the opportunities offered by HIGHSCOPE of National Science Council, LSSH took a much further step to satisfy teachers' needs.

Due to HIGHSCOPE, two research groups were formed, whose main task was to develop courses of inquiry-based learning. The two groups went through different stages of group dynamics. In the first two years, they encountered various difficulties and setbacks; however, they managed to mend the problems and find better ways to accomplish the missions.

Gradually but surprisingly, the originally mandatory groups evolved into interdisciplinary professional learning communities that took a bottom-up strategy to plan their PD sessions. Those teachers became pioneers and explorers in developing inquiry-based learning contents. They were empowered through series of workshops on course designs, PBL, ICT and assessment in additional to content knowledge (See Graphic 2). Their power turned out to be the greatest attribute for the success of course development of inquiry-based learning.

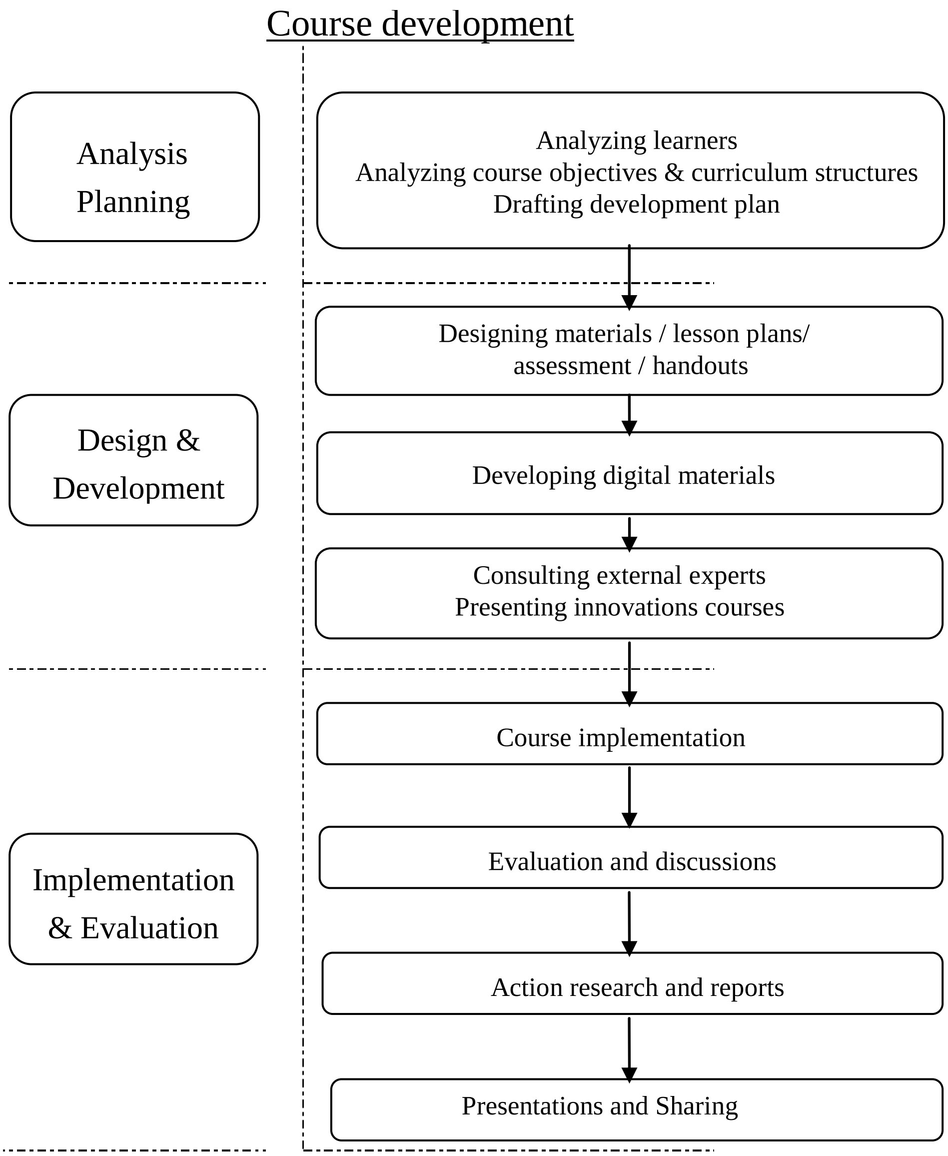


topics	times	topics	times
HighScope Seminars/workshops	10	emerging technologies (workshop)	5
Reading Club	23	project-based learning (workshop)	5
Forums	7	Assessment in the Inquiry-based learning	3
Field trips	5	Innovative teaching (workshop)	2
Course development meeting	24	ICT—MOODLE & software (workshop) (Workshops organized by School of Future, another school-based project)	40
HIGHSCOPE Work meeting	5/per month		

Graphic 2 Professional Development Framework and Contents (2006-2011)

Development Model and Stages

In designing and developing the inquiry-based courses, an instructional design model, ADDIE, was adopted. The course goals were examined closely in the analysis stage. University professors were consulted regularly in every stage. When completed, these courses were delivered, evaluated and revised. These courses serve as good models for teachers who are not very familiar with inquiry-based learning design. Also, through the implementation of the courses, students are guided to know better their roles in the learning process.



Graphic 3 ADDIE Model of Course Development

A. Results (Course Modules and Alternative Assessments)

1. A list of inquiry-based courses

In the first year of HIGHSCOPE, the courses developed turned out to be very knowledge-based rather than inquiry-based due to lack of experiences and professional support. This forced the participant teachers to re-examine the curriculum objectives and framework, plan systematic professional development programs that could meet their needs. In the second year, there came a better framework of curriculum, which encouraged the teachers to try out mini inquiry-based lessons. The continuous PD programs sustained teachers' growth. Their efforts paid off in the last two years. Following the well-defined goals as well as the schedules and anticipated outcomes asked by HIGHSCOPE, the participant teachers finally developed many modules of inquiry-based learning. The themes are listed in Table 2 while nine of them are introduced briefly in Table 3.

Table 2: Themes of Inquiry-based Course Modules

Curriculum stages	**Themes of Module**	Related Subjects
Basic Inquiry	What is Research? (Six Topics)	Cross-interdisciplinary
	Mobile phone rates	Math
	Geological research	Earth Science
	Global warming	Civic Studies
Field Exploration	Using math formulas to solve problems	Math
	Drainage system in LSSH	Earth Science
	Green Battery	Chemistry
	Researches on Mobile phone	Physics
Project Research	liquid crystal display (LCD)	Physics
	Fuel cells	Chemistry
	Astronomical observation	Earth Science
	Eco-biology	Biology
	Nanotechnology	Physics
	Nanotechnology	Chemistry
	Audio research	Physics
	Robotics	Physics
	Rapid heating: Microwave and Ultrasound	Chemistry
	Meteorological Environment Assessment	Earth Science
	Animal vision	Biology
	Workshops on Problem posing, 2009-2011	Cross-interdisciplinary

Table 3: Nine Inquiry-based Course Modules

No.	Topic	Subject
1.	Warming Crisis	Civics
	A. Course design concept ■ Civic action ■ Civic consciousness B. Course goals ■ To understand the current situation and threat of global warming effect in Taiwan.	

- To collect information about various strategies in order to plan anti-warming strategies
- To nurture a passion for scientific research in students,
- To promote awareness of ecological conservation and environmental protection in the technological age
- To develop students' research abilities such as collecting information, reviewing literature, and the ability to plan and implement anti-warming strategies

C. Course plan

- Targeted students: 10th graders
- Course length: 6 weeks
- Instructional focus

  Stage 1 (first 3 weeks): Nurture the proper attitude for scientific research, learn how to search and analyze data

  Stage 2 (last 3 weeks): Plan and recommend anti-warming strategies suitable for the campus. Learn about conducting a survey, studying related topics, and making action plans.

2.	Are Your Cell Phone Rates Cost-effective Enough?	Math

A. Course design concepts

- Transforming real life situations into mathematics
- Heightening interest through experiments and research
- Practicing in group discussion techniques and oral presentation skills

B. Instructional goals

- To learn how to collect data
- To learn how to analyze numbers/data/Statistics
- To apply math formulas to real life problems
- To learn how to conduct a survey

C. Course plan

- Targeted students: 10th graders
- Course length: 6 weeks
- Instructional focus
  - **Stage 1**: Collect data from a survey and change data into readable information through math formulas
  - **Stage 2**: Analyze the results and present the most economic cell phone rate orally so as to give suggestions to their peers

3.	Mobile Phone—Fun!	Physics

A. Course Design Concepts

- Experimenting on scientific theories through hands-on operation
- Practicing skills through practical experience
- Conducting physical measurements and actualize abstract concepts by utilizing computers, instruments, and everyday objects
- Presenting the findings by giving multimedia presentations
- Promoting creativity through hands-on experimentation with the topics of cell phones

B. Teaching Objectives

- To incorporate the topics of cell phones into the creative thinking process
- To conduct experiments and polish skills systemically
- To present the results of group cooperation and research

C. Course Plan

- Targeted students:10th graders

- Course length: 5 weeks
- Instructional focus
  - **Week 1**: Understanding the physical traits of cell phones and planning creative experiments
  - **Week 2**: Receiving necessary training and learning to make research plan for cell phones experiment
  - **Week 3**: More training with hands-on application
  - **Week 4**: Conducting cell phone experiments and get results
  - **Week 5**: Giving presentation on creative cell phone experiments

4.	Save the Earth, Go Green Batteries	Chemistry

A. Course Design Concepts
- Incorporating research ability and creativity into instruction
- Using open-ended experiments for instructions
- Focusing on student-centric hands-on experiments

B. Teaching Objectives
- To train basic lab techniques
- To enhance inquiry skills
- To explore issues and resolve scientific questions
- To learn about environmental protection and emerging technology

C. Course plan
- Targeted students: 10 graders
- Course length: 4 weeks
- Instructional focus
  - **Week 1**: Fundamental labs--mix solutions and the concept of conservation of mass.
  - **Week 2**: Intermediate labs--acid, oxidation, and reduction titration labs.
  - **Week 3**: Lab application-- voltaic cell.
  - **Week 4**: Create one's own creative green battery.

5.	Meteorological Environment Assessment	Earth Science

A. Course design concepts
- Cross-subject learning and research
- Flexible utilization and consolidation of information
- Improvement in scientific literacy

B. Instructional goals
- To learn to be an earth scientist
- To gain further understanding of experiment and research protocol
- To understand techniques of using tools and software

C. Course plan:
- Targeted students: 10^{th} graders
- Course length: 5 to 6 weeks
- Instructional focus
  - Allowing students to learn in groups using the PBL method
  - Analyzing environmental conditions and restrictions of wind power
  - Learning statistical analysis of weather databases
  - To create and present charts, composition and evaluation

6.	Liquid Crystal Display	Physics

A. Course Details
- Understanding LCD Products
- Discovering LCD Principles
- Designing interesting LCD Experiments

B. Teaching Objectives (students are able…)
- To give 3 examples of how flat panel display devices are important to us
- To detail the basic characteristics of LCD technology
- To give 2 examples of liquid crystal products
- To understand how to execute experimental production of liquid crystal cells
- To execute liquid crystal technology experiments
- To propose topics on liquid crystal technology for extended research purposes

C. Course plan
- Targeted Students: 10th graders
- Course Duration: 3 weeks
- Instruction focus
  - To achieve the goal of having our students garner basic Scientific knowledge through hands-on experiments so that they can gain new knowledge on emerging technologies
  - To leverage "Problem-Based Learning" to strengthen our students' ability to "Predict, Observe and Explain"
  - To give our students an opportunity to understand the current circumstances of visual display industry and technologies and its future application
  - To utilize actual operational methods so that our students can understand LCD principles

7.	Rapid Heating of the Chemical Experiment: Microwave and Ultrasound	Chemistry

A. Teaching Objectives
- To understand the principles behind microwave and ultrasound technologies
- To undergo experiments on microwave and ultrasound technologies
- To extend the principle applications of microwave and ultrasound technologies

B. Course Plan
- Targeted Students: 10th graders
- Course length: 3 weeks
- Instructional Focus
  - The principle applications of microwave and ultrasound technologies
  - How to use microwave and ultrasound technologies in our daily lives.
  - Things to note when using these technologies
  - The applications and experiments of chemical synthesis

8.	New Vision in Astronomy: Small Telescope's Observation and CCD Photography	Earth Science

A. Course Design Concepts
- Learning all about the small telescope, including how to dismantle and assemble the device
- Learning about astronomy photography using the new digital receiver and computer

B. Teaching Objectives
- To understand the principles of the small telescope
- To learn how to dismantle and assemble the small telescope
- To use the digital receiver when engaging astronomy photography

C. Course Plan
- Targeted Students: 10th graders
- Course lengths: 5 weeks
- Course Highlights
  - **Week 1**: Introducing the telescope and how to dismantle and assemble this

	device ● **Week 2**: The functionality and specification of the telescope, and how to calibrate and track the device ● **Week 3**: The photography principles, assembly, dismantlement and software operation of DSI ● **Week 4**: Night practice sessions ● **Week 5**: Student Presentations	
9.	**Plant Reproduction**	**Biology**
	A. Course Design Concepts ■ Research Courses on Emerging Technologies ■ Collaborative Learning and Exploration of Reproduction Ecology B. Teaching Objectives ■ To experiencing and understanding reproduction ecology ■ To stimulating innovative experiment design C. Curriculum Planning ■ Targeted Students: 10^{th} graders ■ Course Duration: 3 weeks ■ Course Highlights: ● Introducing Research Content and Development of Plant Reproduction Ecology ● Observation Activities of Flower Structure ● Experiments on Testing Pollen Viability ● Anthocyanin Electrophoresis	

Among the nine courses, the first 5 modules are applied to the first six weeks of Research Methods; the rest of the courses that focus on emerging technologies are delivered in “Project Exploration.”

2. Alternative Assessments

In struggling of designing inquiry-based courses, the teachers encountered another challenge—how to assess students’ performances. It is agreed that the inquiry-based learning demands more than paper-and-pen assessments, which is traditionally employed to test knowledge understanding. Some other aspects such as skills and habits of mind need to be taken into account as well. However, while it was recognized that the school-based curriculum was not fully complete without a sound assessment system, alternative assessments were seldom touched upon until recent years. In School Year 2008, HIGHSCOPE teachers developed different rubrics or checklists and put them into use. The rubrics or checklists helped to evaluate the quality of research plan, data collection, experiment operation, oral presentation, group dynamics, and so on. In the following year, more teachers adopted and customized the rubrics according to the characteristics of different subject requirements. Even so, a need for a more systematic assessment approach constantly reminds us to go further. The system should be able to assure that no matter what project students are working on, they are expected to develop the same competencies, which can be checked with common criteria. This will be a great task for us to accomplish in the near future.

IV. Achievements & Impacts

The process of refining the school-based curriculum and developing inquiry-based courses has helped transform the teaching environment into a learning organization. A certain time slot is arranged and reserved for different learning communities so that members can meet and focus on professional discussions and learning. The teachers put what they learned into practice, which also gradually changed their teaching styles. Since “Resarch Methods” and “Project Research” aim to promote independent learning and inquiry skills by having students focus on one research project, teachers have to adopt the “student-centered approach” and learn facilitating skills. When teaching regular subjects, some of them try to employ the same stratgies. They innovate teaching activities and integrate ICT into teaching to promote higher-level thinking. The changes are welcome and the impact are favorable. Other achievements and impacts of school-based curriculum and inquiry-based learning are presented from two aspects as follows:

A. Students’ Learning Performances

The inquiry-based learning in the school-based curriculum enables every “Lishaner” to discover and expand their potentials to the fullest. Compared with their counterparts in other high schools, our students receive a lot more training to develop necessary competencies in science inquiry, problem-solving, data process, teamwork, time management and oral presentation. The learning experiences help LSSH graduates adjust to university life more smoothly than their peers. This was confirmed by a whole-school survey conducted in 2008. One of the questions in the survey asked students to rank a list of skills or competencies they had developed in the school-based curriculum. The result is presented below.

Table 4: Top 10 Skills/Competencies Chosen by Students (2008)

	Grade 10		Grade 11		Grade 12	
order	**item**	**%**	**item**	**%**	**item**	**%**
1.	Report writing	77.7	Oral presentation	86.7	Oral presentation skill	80.0
2.	Oral presentation skill	77.7	Knowledge synthesis	80.0	Team work	76.0
3.	Problem solving	74.8	Report writing	80.0	Report writing	76.0
4.	Knowledge synthesis	73.8	Team work	76.7	Communication skill	68.0
5.	Team work	73.3	Data searching	73.3	Knowledge synthesis	64.0
6.	Data searching	72.3	Problem solving	68.3	Problem solving	56.0
7.	Creative thinking	59.7	Communication skill	65.0	Data searching	48.0
8.	Active learning	59.2	Creative thinking	60.0	ICT skills	40.0
9.	Communication skill	58.3	Active learning	58.3	Creative thinking	40.0
10.	ICT skills	54.9	ICT skills	53.3	Active learning	40.0

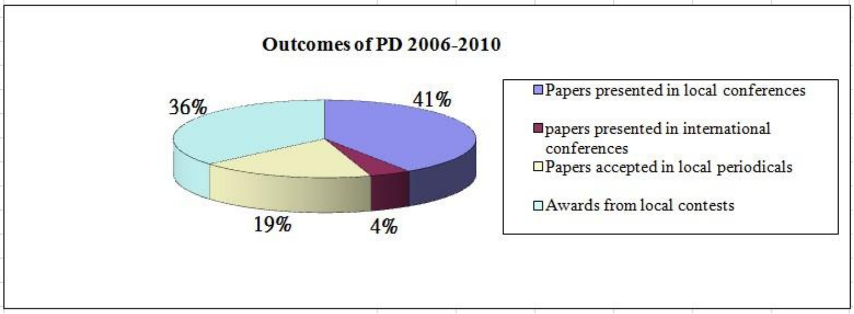
An added value from the featured courses is that in the two-year process, all students are devoted to a chosen project. To extend their learning, they are encouraged to take part in different extracurricular science activities such as science fairs or contests, either locally or oversea. Since 2000, Lishan High School has gained distinguished achievements in terms of scientific research due to the implementation of the school-based curriculum and inquiry-based learning. So far more than 300 domestic or international science awards have been earned, including two times of first-prize at Intel® International Science and Engineering Fair (Intel ISEF) and other honors from International Science Fairs in Canada, South Africa, Singapore and Korea. Participating in such international events not only broadens the scope of scientific research in Taiwan, but heightens the visibility of Lishan in the international arena.

B. Teachers' Achievements

Implemeting the school-based curriculum has invovled all the science and math teachers since 2000. In recent years, the number of participant teachers has increased since we included language arts and social studies in the program. The teachers recognize that in this modern time, they need to be life-long learners and constantly reconstruct or advance the subject knowledge and pedagogical practices. In particular, when inquiry-based or project-based learning is adopted, teachers need to learn many related knowledge, skills and strategies to make learning work. Even though most of the teachers have a master's degree, in-service trainings on course design, teaching and learning strategies such as PBL or inquiry-based learning, ICT integration and emerging technologies are in high demand. This explains why PD has been playing an important role in teachers' life here.

There are two types of PD programs: "Bottom-up" and "Top-down." In the former case, the themes and topics are discussed in department meetings or cross- disciplinary learning communities in the beginning of the semester. "Top-down PD programs," which is usually overarching workshops or seminars, are planned and arranged by the administrators.

Categories	2006	2007	2008	2009	2010	Total
Papers presented in local conferences	1	1	12	17	6	**37**
papers presented in international conferences				3	1	**4**
Papers accepted in local periodicals		2	4	7	4	**17**
Awards from local contests	1		7	17	8	**33**
	2	**3**	**23**	**44**	**19**	**91**

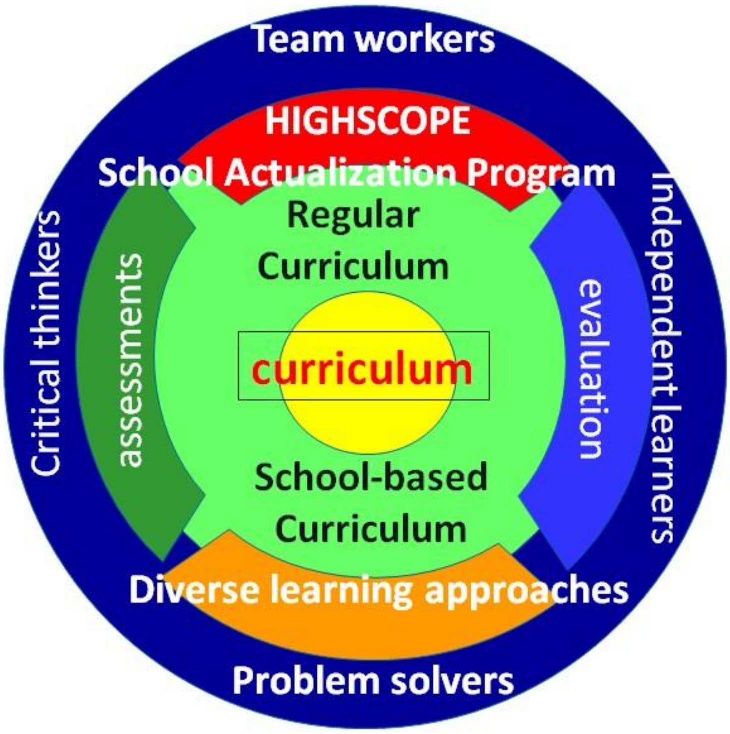


Graphic 4 Teachers' Outputs (2006-2010)

In addition to seeking professional learning opportunities, our teachers are encouraged to share innovative teaching expeiences. For the purpose, "Lishan Teaching Forum" is held every semester and "Lishan Journal" is published annually. Many of the participant teachers in HIGHSCOPE set a good example by becoming action researchers themselves. Like the students, our teachers not only grow profesionally but also build quite a good reputation over the past years (See Table 4, Teachers' Outputs from 2006-2010).

V. Conclusion: Looking forward

"Research Methods" and "Research Project" have been implemented for over one decade in LSSH. All of the innovative reforms or attempts in the process are meant to reach the objectives and goals of the curriculum. Breaking through conventional teaching and learning practices is never easy, so it is natural to encounter skeptical questions, criticism, obstacles and setbacks. We have to admit that so far we have not achieved all of the ideals in our framework. However, inspired by our teachers and students, no matter how challenging it is, LSSH will be persistent on innovating in science education. The future tasks are illustrated in Graphic 5.



Graphic 5 Future Tasks for Curriculum Development

Enhancing the quality of curriculum remains the core of our future work. To have broader impact, we hope to transfer the successful experiences in the school-based curriculum to the regular one in the long run. Through curriculum implementation, we expect to transform our learners into critical thinkers, problem solvers, independent learners and critical thinkers. To attain desirable results, we will continue…

1. promoting diverse learning approaches such as inquiry-based learning and project-based learning;

2. seeking support from national projects such as "HIGHSCOPE" or "School Actualization" (an MOE initiative aiming to promote the quality of high schools in Taiwan);
3. designing a systematic assessment system for curriculum. The system should be valid and reliable and can be applied to every subject in the framework
4. seeking chance of a large-scale curriculum evaluation whose results will be indicators for future development and improvement.

In addition to above tasks, we feel obliged to share the successful experiences of LSSH with anyone who wants to take up innovative teaching approach such as inquiry-based or project-based lessons. Meanwhile, we would like to learn from other successful cases. This leads to the final task—connection. We cordially invite educators who dream to develop their science programs to join us to explore further possibility. We believe collaboration will benefit all participants, as is proved in the stories of LSSH.