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WE WISH YOU A HAPPY 2013

Words from the EASE President, Professor Chi-Jui Lien

After the successful 2012 EASE Summer School hosted by Beijing Normal University, many young and potential science educators joined the EASE Association. I would like to express the warmest welcome to all new members, on behalf of the Association. The EASE will keep growing only when more science educators join the Association and work together for better science education. To our new members, I wish you find all the support that you might need in the Association.

I also welcome a new member of the Executive Board of the Association, DR. Hisashi OTSUJI, Ibaraki University, Japan. Professor OTSUJI has known well by many science educators in EASE for his excellent contribution on editing EASE newsletter as Chief-editor for years. He is professional and enthusiastic. I believe science educators in Japan and other parts of the world will have his assistance, if needed. Executive Member, Professor Manabu SUMIDA, Ehime University, will still be on the Executive Board and serve as the Treasurer. I appreciate all support to the Association and science education in regions given by Professor OTSUJI, Professor SUMIDA, and many Japanese science educators.

Prof. OTSUJI

Prof. TUAN

We also congratulate that the Executive Board Member of EASE, Professor, Hsiao-Lin TUAN, is elected to be the President of the Association of Science Education, Taiwan (ASET) from 2013. It is believed that the collaborations among ASET, EASE and many other science education societies in regions will be continuously strengthened.

Finally, to enhance academic collaboration between EASE and academic societies in constituent regions, Executive Board Members have approved the "Guideline for strengthening the cooperation between science education societies of all regions and EASE to co-organize academic activities" (as follows). If EASE members are interested in cooperation activities, please submit the proposal to the headquarters according to the requirement of the guideline.

The EASE belongs to science educators in regions. It is in science education profession, yet full of friendship and supports. Your involvement and continuous support are crucial to EASE. Please, JOIN EASE and JOIN OUR EFFORTS!

Guideline for strengthening the cooperation between science education societies of all regions and EASE to co-organize academic activities:

1. The aim of this guideline is to enhance academic collaboration between EASE and academic societies in constituent regions.
2. Types of cooperation include co-organizing, authorizing, or recognizing academic activities, such as academic visits, conferences, workshops, contests, etc.
3. Submission procedures:
   (1) Proposal format: No less than one-page singular space of proposal, including the title, date, objectives, cooperation type, and background of the academic activity. In addition, please specify what EASE needs to do for the activity (ex. announcing, promotion, contacting potential speakers, invitations, etc.)
   (2) Prepare a proposal approved by all EMs in respective regions.
   (3) Submit the proposal to the Headquarters 10 months before the activity.
   (4) The proposal will be circulated and approved by the board of EMs before officially endorsed by the EASE Association.
4. There is a limit of two approved proposal each year, in principle.
5. This guideline applies to activities getting funding support or without funding support from EASE.

We are very pleased to invite EASE members and other science educators and scientists to the forthcoming EASE 2013 conference. This conference will be held at the Hong Kong Institute of Education, Hong Kong, China Mainland, on 4–6 July, 2013. Hong Kong, the Pearl of the Orient, is Asia's financial hub for international commerce and a gateway into China Mainland, where both Eastern and Western cultures coexist harmoniously. We are sure that you will enjoy the vigor, beauty, modernity, and diversity of Hong Kong.

The theme of the EASE 2013 Conference is "Building an international platform for exchange between scientists and science educators". We hope that the two academic groups of science and science education in East Asia and across the world can be meaningfully and truly integrated at the conference through the active exchange of ideas, research findings, and expertise.

We sincerely believe that the EASE 2013 Conference will be a place where you can share your research interests, build relationships with your colleagues, and enjoy Hong Kong. We look forward to meeting you in Hong Kong in July 2013.

CHENG, May Hung May
Chair, Organizing Committee of EASE 2013 conference
Hong Kong Institute of Education
WONG, Siu Ling Alice
Vice Chair, Organizing Committee of EASE 2013 conference
University of Hong Kong
YEUNG, Yau Yuen
Vice Chair, Organizing Committee of EASE 2013 conference

FOR FURTHER INFORMATION: http://new.theease.org/conference.php

STRENGTHENING THE COOPERATION BETWEEN EASE AND ASET

–Report from 2012 ASET International Science Education Conference, Taipei, Taiwan

Yu-ling Lu
Department of Science Education, National Taipei University of Education, Taiwan

ASET is the Association of Science Education in Taiwan. Its 2012 ASET Annual International Science Education Conference was successfully held in National Taipei University of Education, Taiwan, from December 13-15, 2012.

The Conference inherits 27 years' experiences and tradition which accumulated by science educators in Taiwan. In 2012, the ASET Science Education Conference in Taiwan turns into an international event, based on the Board Resolution of the Association. With dedication to incorporate more academic facets and to take heavier responsibilities, the leap shows its true value, especially when the global communities commonly regarded exchange and cooperation are more important than ever before.

With the theme, "Variety, Innovation and Sustainability," the conference has provided researchers and educators in science with a platform for communication. By means of academic exchange, share and cooperation, many diverse and innovative paths of high-quality science education, as well as to construct a blueprint for the sustainable development of science education have been discussed in the conference.

This conference featured a strong and rich program including 6 very intriguing and inspiring keynote speeches delivered by international eminent scholars, including, Professor Marcia C. Linn, Graduate School of Education, University of California at Berkeley; Professor Mike Sharples, Institute of Educational Technology, Open University, UK; Professor Enshan Liu, The College of Life Sciences, Beijing Normal University, China Mainland; Professor Jinwoong Song, Department of Physics Education, Seoul National University, Korea; Professor Huann-Shyang Lin, Center for General Education, National Sun Yat-Sen University, Taiwan; Professor Ying-Shao Hsu, Graduate Institute of Science Education, National Taiwan Normal University, Taipei, Taiwan.

In addition to the keynote speeches, there were more than 250 research papers presented. This conference also hosted a Science Fair composed of 21 exhibition booths, as well as 6 workshops. This conference attracted more than 1,500 science educators, teachers, and students from elementary to graduate school, and has become one important event of science education for science educators in Taiwan or many science educators from other places.

The ASET conference has been dedicating to establish a strong connection with the EASE Association. We appreciate Former President of EASE, Professor Jinwoong Song, and current Vice President of EASE, Professor Youngmin Kim, Pusan National University, and many EASE members' participation. For promoting the professional exchange, the 2012 ASET conference has officially encouraged all participants to be in the 2013 EASE Conference, which would be held in Hong Kong, July 4, 2013.

The next 2013 ASET Conference is officially recognized by the EASE Association and will be held in December, 2013. Currently keynote speakers from East-Asia regions are inviting to share their research findings or regional best practices. The venue is in the National Changhua University of Education which is located in the central part of Taiwan and is about two-hour transportation from Taipei City. The Changhua City, Taiwan, is known for its friendly atmosphere and its nearby scenic mountains. We are looking forward to seeing you and your colleagues to share your research in the 2013 EASE in Hong Kong and the 2013 ASET in Taiwan!

(Attached Photos: The 2012 ASET Conference, the group photo, presentations, and the science exhibitions)

Well begun is half done.--- Horace

A Science Education Festival Feast to SODA Teachers in China Mainland

Li QIN (Intel China, Beijing, China Mainland)

With strong support from EASE, Intel (China) Ltd. invited Prof. Lien Chi-jui, Prof. Tuan Hsiao-lin, Prof. Chin Chi-chin from Taiwan, and Prof. Liu Enshan from Beijing Normal University to conduct 2 days training workshop on August 14-15, 2012, in conjunction with 27th China Adolescent Science and Technology Innovation Contest (CASTIC), the biggest national science completion for youth, in Yinchuan, a city locates in Northwest of China Mainland.

The training was delivered to 30 participants from the SODA (School of Distinction Award) Winning Schools. School of Distinction Award (SODA) is an original US-based award presented by Intel Corporation to recognize schools for implementing innovative math and science programs in K-12 school. The award with funding from Intel Foundation, Intel China worked with CAST to launch the China School of Distinction Award (SODA) Program in year of 2010 to recognize outstanding schools in driving innovations in science education. 30 schools had been awarded the title of "SODA" School in China Mainland since year of 2010.

Prof. Lien is giving lecture

The training covered these areas: Problem based learning in science classroom, how to help students develop questions, inquiry based teaching and learning, inquiry activities, curriculum and teaching in East Asia region. From designing, mentorship to youth, teaching methodology in classroom, students attributes development in science teaching, assessment and evaluation to project based learning…, the 4 professors presented a great festival feast with science education to participants.

"The training content from 4 professors has reshaped not only the models of STEM teaching and learning, but also transformed my mind as a science teacher." Said by Shen Tao, a science teacher from Nanjing Tianjiabing Middle School. Shen shared his 8 paged notes taken from the workshop, said highly about the content and the passion of professors on science education. According to him, he will use the methodology and models learned from the workshop when he is back to school, to benefit more for his students.

In addition to the lectures delivered by 4 professors, some of the participants shared case studies on STEM education, either from top schools in city or the small school from village. The next step lesson plans with integration of learning from the workshops also developed by teachers, as advised by the trainers.

Prof. Tuan and Prof. Chin are giving lectures

Expressing his feedback about the training workshop, Mr. Yang Chao, the principal from Chengganglu Central Elementary School, Laizhou city of Shandong Province, stated "As a teacher from a rural school and living in an era which is dominated by science and technology, we're facing big challenge on the inquiry based learning and teaching. The training workshop helped me shorten the distances with the excellent practice and give me more confidence for future work. "

The training workshop was a great success in building the relations between the teachers with the educators, and the teachers from different schools. In a text message to event coordinator, Ms. Ma Lixia, the science teacher from Beijing No. 101 Middle school said "I enjoyed the content, the professionalism that the trainers shown in the workshop. I will apply all these learning in my classroom. I'm looking forward to the next training right after the ending of this one."

人生に夢があるのではなく、夢が人生をつくるのです。——宇津木妙子　　不是人生中有夢想；是夢想造就了人生。

International Conference on Science Education 2012 (ICSE 2012) Was Held in Nanjing, China Mainland

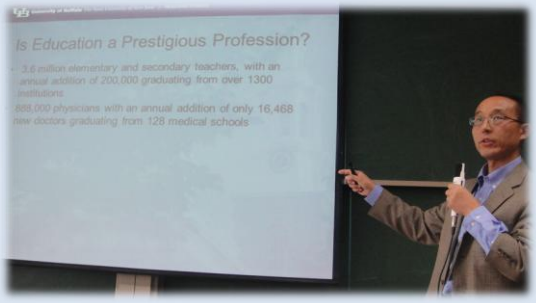
Prof. Baohui Zhang, the Institute of Education, Nanjing University

The International Conference on Science Education 2012 (ICSE2012, Nanjing, China Mainland) was held from October 12th to 15th in Nanjing University, China Mainland. This is the largest international conference on science education since the establishment of the Chinese Science Education Association in 2009. It should also be the largest conference of its type in China Mainland in the past 10 years. The conference was hosted by the Chinese National Association for Science Education and the Institute of Education, Nanjing University. The conference has an international committee constituted by world-known science education scholars from 22 countries and regions. The themes of the conference were international K-12 science education standards, popular science education, and science teacher education.

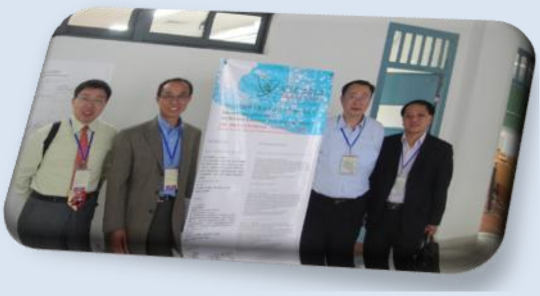
ICSE 2012 Conference co-Chairs, (From left to right) Professors Shujin Peng, Xiufeng Liu, Hongshia Zhang, and Baohui Zhang

The conference had 12 well-known invited speakers from 5 countries. There were 122 delegates from 15 countries and regions attended the conference. The opening ceremony was held on the first day following 9 invited presentations. On Day 2, there were 3 invited talks and 55 presentations during concurrent sessions and 14 posters. Four international scholars participated the conference through web conferencing system. On Day 3, there were three panels on science education standards, science teacher education, and public science, respectively; there was also one workshop on publishing on science education journals. Selected English papers will be included in a proceeding published by Springer; Selected Chinese papers will be included in a proceeding published by the Chinese Science and Technology Press. Best papers will be recommended to be published on an SSCI journal—the Journal of Science Education and Technology.

Mr. Baiyu Shen from the Department of Basic Education, M.O.E., China Mainland, Mr. Jinbo Hu, Deputy Director of Jiangsu Education Ministry and Professor Zhemin Tan, vice president of Nanjing University were invited as the guests of honor at the opening ceremony. Mr. Hu and Prof. Tan also gave their welcome speeches. The twelve invited speakers are: Professor Sharon Lynch, President of the National Association of Science Teaching, USA; Zuoshu Wang, deputy director of the Education Committee of the National People's Congress, president of China's Private Education Association and Professor Capital Normal University; Professor Joseph Krajcik, Michigan State University, USA; Dr. Ben Akpan, President, International Council of Associations for Science Education (ICASE), Nigeria; Prof. Shujin Peng, vice-president, The Chinese Science Education Association; Mr. Peter Nentwig, Professor of Kiel University, Germany; Prof. Fujun Ren, Director of China Research Institute for Science Popularization; Prof. Xiufeng Liu, the State University of New York at Buffalo; Professor Zuyi Du, University of Michigan and The Chinese University of Hong Kong; Professor Dongchuan Yu, South-East University, China Mainland; Prof. Shigeki Kadoya, Director of Department for Curriculum Research, National Institute for Educational Policy Research, Japan; and Professor Hongshia Zhang, Dean, Institute of Education, Nanjing University, China Mainland. For more information, please visit the conference website: http://edu.nju.edu.cn/zbh/icse2012/.



Prof. Xiufeng Liu is giving lecture



Inspiration of 'Learning by Doing' IBSE Program in China Mainland after 11 Years Practice

Zhaoning YE, Jianzhong ZHOU

Key Laboratory of Child Development and Learning Science, Ministry of Education; Education Center for Learning by Doing Science Education Reform Pilot Program, CAST; Thinktank: Handsbrain Education, Jiangsu

1. The Concept of "Learning by Doing" (LBD) Science Education Reform Pilot Program

There is universal recognition that the pace of change in the world today requires a constant review of what is effective education, particularly in science and technology. The eventual goal of science education is to produce individuals capable of understanding and evaluating information that is, or purports to be, scientific in nature and of making decisions that incorporate that information appropriately, and, furthermore, to produce a sufficient number and diversity of skilled and motivated future scientists, engineers, and other science-based professionals. [1]

With more and more development of scientific research works, changes in understanding of what children know and how they learn have been profound in the past several decades. So since 1994, China Mainland has been involved in the international cooperation on children's science education reform launched by the International Council of Scientific Union (ICSU). In 2001, the M.O.E., China Mainland and China Association for Science and Technology (CAST) co-launched a pilot program of "Learning by Doing" science education reform (hereinafter to be referred to as LBD Program). At the beginning the nine principles were set up as the fundamental criterions. [2] The nine principles are:

- Orientation to every child and taking into account difference between individual children.
- Laying foundation for child to learn through his/her lifetime, and more importantly, for children to learn how to live.
- Teaching contents should be derived from life and drawn from the surroundings.
- To guide the children to take the initiative to explore and experience the process of inquiry.
- Teachers are the supporters and guides for the children to learn science.
- Using encouraging assessment, including formative assessment.
- The scientists and educators will carry out the science education jointly.
- The power of communities and families will be fully mobilized to support science education.
- The modernized internet will be used to promote the domestic and international exchanges and cooperation.

LBD Program is an inquiry-based, student-centered science education program for children aged 5-12, guided, organized and facilitated by teachers, and characterized by their active involvement in learning, making it possible for them to be both hands on and minds on, in order to foster children's scientific way of thinking and of living, cultivate qualified citizens with higher scientific literacy and facilitate the progress of quality education for all. [3]

According to the theory of new Learning Science, the key point is that learners are constructing their understanding, sometimes through their own thinking and sometimes in collaboration with others. [4] That means one of the hallmarks of the new science of learning is its emphasis on learning with understanding. There is a great deal of evidence that learning is enhanced when teachers pay attention to the knowledge and beliefs that learners bring to a learning task, use this knowledge as a starting point for new instruction, and monitor students' changing conceptions as instruction proceeds. [5] Inductive teaching and learning method is supported by this new science of learning. It is an umbrella term that encompasses a range of instructional methods, including inquiry learning, problem-based learning, project-based learning, case-based teaching, discovery learning, and just-in-time teaching. These methods have many features in common, besides the fact that they're all qualify as inductive. They are all learner-centered (also known as student-centered), meaning that they impose more responsibility on students for their own learning than the traditional lecture-based deductive approach. [6]

LBD Program advocates using inductive methods to teach kindergarten and primary school science. While the quality of research data supporting the different inductive methods is variable, the collective evidence favoring the inductive approach over traditional deductive pedagogy is conclusive. Induction is supported by widely accepted educational theories such as cognitive and social constructivism, by brain research, and by empirical studies of teaching and learning. Inductive methods promote students' adoption of a deep (meaning-oriented) approach to learning, as opposed to a surface (memorization-intensive) approach. [6]

Since 2001, LBD Program has been expanded to the current 22 pilot areas and about more than 620 kindergartens and 1,100 primary schools being involved from the initial four pilot areas and 44 schools. More than 200,000 students participated in the LBD Program. It has accumulated a great deal of valuable experiences, thus laying an important foundation for the revising the National Science Education Standard of Primary Schools in China Mainland. The innovation has already gained initially successes.

2. The Content Standard of LBD Program

After 6 years of practice, Content Standard of LBD program was drafted in 2006. On Sep. 2006, the Elementary Education Department, M.O.E., China Mainland, together with China Association for Science and Technology and China Academy of Sciences, held the Symposium on "Learning by Doing" Science Education Content Standard to discuss this standard with 8 Academicians and more than 50 scientists, science educators and science teachers from pilot areas. With the permission and support of MOE, CAST and CAS, the content standard was published by the People's Education Press in 2007. This science education content standard — the core ideas of science education — specifies what concepts and knowledge students are expected to learn, what inquiry-based activities they are able to be involved in, and what skills and competence they are to develop and master.

The content standard firstly gives the general requirements, covering the fundamental concepts and their detailed descriptions in material and physical science, life science, the earth and environmental science, and design and technology. And then, the decomposition and exemplification of the key concepts in the above-mentioned domains are presented, as we believe, based on our experience of developing the modules and teaching practice, which the concept decomposition is of great use, not only for module development, teacher training, but also for teaching practice. In this document, the main scientific concepts are given detailed decomposition and examples. Meanwhile, the content standard also gives some content about developing inquiry skills and social emotional competence, which emphasizing science education in kindergartens and primary schools should pay special attention to fostering children's empathy, sympathy and self-esteem[7].

3. The Resources Building and Teaching Practice of LBD Program

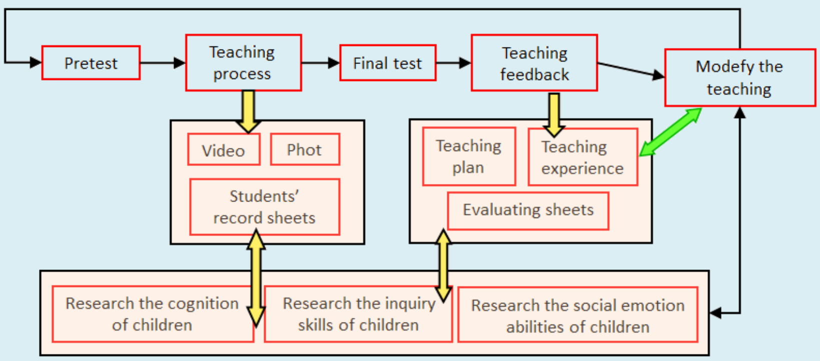
Under the guidance of the Content Standards, LBD Program team has designed 29 teaching modules (Table 1). These teaching and learning modules include teacher guide book, teacher training manual, student notebook, and teaching toolkit. All these modules have been practiced and used in the LBD pilot schools, and further been modified based on the feedback of practice to ensure effectiveness of teaching.

Table 1: teaching modules of LBD Program

Grade	Module			
	Material and Physical Science	Life Science	Earth and Environmental Science	Design and Technology
Kindergarten	● Fruit basket ● Water and ice	● Find the world ● Senses	● Air	● My boats
Grade1～2	● Solid and liquid ● Force and motion	● Silkworm ● Plant growth	● Weather ● Soil	● Little architects ● Simple machines
Grade 3～4	● Sound ● Change in water ● Electro circuit ● Coldand hot	● Eco-systems ● Ourselves	● Rocks and minerals ● Earth and the sun	● Making car ● Electric Car
Grade 5～6	● magnetic and electric ● Light	● Micro world	● Protect the environment	● Flight

These modules are quite different from traditional science curriculum in China Mainland. The inductive teaching methods are used in the classroom. According to the modules, students will identify questions that can be answered by investigation activities, predict results, describe observations, design plans, collect information, think critically and logically in analyzing and interpreting evidence, draw conclusions, and communicate with others in the science classroom. At the same time, teachers will lead students to develop the skills of inquiry and the understanding of science concepts through the students' own activity and reasoning. This involves facilitating group work, argumentation, dialogue and debate, as well as providing for direct exploration of and experimentation with materials.

Fig.1. Using formative assessment in STE



LBD teaching practice, formative assessment is adopted to evaluate children's development (Fig.1). Formative assessment is a kind of teaching evaluation method as opposed to summative assessment. It is essentially carried out by teachers. This means that it is ongoing and a regular part of the teacher's role. However, the fact of being carried out regularly does not necessarily mean that the assessment serves a formative purpose. It depends on how the results are used and who uses them. Formative assessment includes diagnostic assessment, since "diagnostic" carries the connotation of concern with difficulties to decide the appropriate next steps in learning both for those who succeeded in the earlier steps and for those who encountered difficulty. [4]

Formative assessment can be summarized in three central questions to be answered by the student or the teacher: Where are you going? Where are you now? How are you going to get there? This three-step process summarizes what has been called the "feedback loop" in formative assessment: setting a learning goal, determining the gap between the learning goal and the student's present state of understanding, and formulating feedback to close the gap. [1]

So, in LBD Program, different evaluation indices are designed according to the standard with different teaching contents, and the data collection methods include: Observation of teacher and student activities in the classroom, particularly the characteristics of their inquiry activities; Noting of science content of lessons; Logging of classroom discourse; Examination of teacher journals; Teacher assessment practices; Examination of student writing/drawing, including student notebooks lab records; Interviews with teachers and selected students; Continuous assessment of student progress through teacher observation and records; Assessment of student basic concepts and understanding through tests embedded in the curriculum; Questionnaires on students' attitudes towards science and science inquiry. Teachers use those indices to assess the students' outcomes, such as science concept, inquiry skill, expression and language development, reasoning ability, classification, cooperative skill, motivation and attitude, and social emotion competence etc. The evaluation results provide the basis for teachers to adjust the teaching contents and strategies.

4. The Teachers' Professional Development of LBD Program

From the beginning of LBD program, teachers' professional development has become the key task of program implementation. Within these PD activities, we have developed four different models according to the requirements of participants, with various contents, methods and duration. They are introduction training, module training, high level training and trainer training (Table 2). In order to enhance the teachers' PD and learning, it is necessary to develop research tools and establish research schools with the alignment of curriculum, instruction, and assessment practices to help teachers better manage their instruction, making teaching and learning more effective and efficient. Therefore we develop a multimedia database to collect useful materials for PD training, such as podcast, videos, photos, students' notebook and teachers' notes from science classrooms.

Table 2: different mode for teaching training

Model	Participants	Major Contents	Methods	Duration
Introduction	Teachers and trainers get entrance to LBD	Introduction of Science, IBSE, and LBD Instruction of IBSE Assessment of IBSE	Special Lectures Topic discussions Practices of IBSE Classroom visit Simulation of classroom activities	2 weeks
Modules Instruction	Teachers	Science concepts Experiment design Teaching strategies Implementation of formative assessment	Demonstration and simulation of classroom teaching Topic discussion Interaction between module developers and teachers	Three days for 1-2 modules
High Level Training	Teachers and trainers who have teaching experiences in LBD	Content Standard of LBD Core Concepts of Standard Curriculum design and case study Design of formative assessment	Lectures Topic Discussion Case study on classroom strategies Classroom visit Classroom teaching demonstration and analysis	1-2 days
National training for trainers	Trainers and researchers	Overview of the development of IBSE in the world Scientific basis of Learning science and child development Content Standard of LBD Strategies discussion and case study	Lectures Demonstration and discussion on strategies of PD Practices and analysis of PD	7-10 days

In 2009, a new round of national science curriculum training started to promote the new national science education standard. In these professional development activities, we used more teaching practice analysis through case studies, full use of information technology to make the training content more in-depth and to provide continuing education and research guidance. After 11 years of practice, the traditional science teaching mode has been changed from lecture-style (transmission-based) to inquiry-based in LBD pilot schools.

5. The Inspiration of LBD Science Education Reform

As the initiator of LBD Program, academician Wei Yu has summarized the four successful inspirations of LBD Program at the national annual meeting in 2008. [8]

5.1 Strengthen the participation of the science field together with the education field

Reform and development of science education in China Mainland need an effective platform, on which the areas of education and science can join together and pull together.

5.2 Stress the support of scientific research platform

Educational reform must be implemented seriously in scientific attitude and supported persistently by scientific researches.

5.3 Persist in innovation based on international communication

In order to explore the science education reform in China Mainland, we must insist on persistent international cooperation and communication; on the other hand, after introducing and digesting advanced international science education concepts and achievements, we must persist in developing our own materials for students and teachers, on the basis of practice of science education in China Mainland.

5.4 Apply latest information and internet technology

At the very beginning of the LBD project, the Website of Handsbrain has been set up based on the 9 principles of LBD. In recent years, advanced online multimedia database has been developed, seeking for a way to continuously support teachers' PD, as well as studying on an open platform on scientific education researches.

After 11 years of practice, we can realize that the core issue of modernization of education is the change of research methods in education. In China Mainland, if we want to achieve this change, we must rely on the cooperation of the educational circles and the scientific community and also should begin from the construction of basic team.

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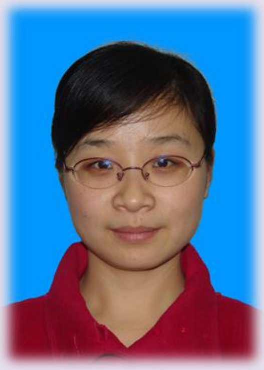
Mrs Zhaoning YE is associate professor of Research Centre for Science Education, Southeast University, China. She is also associate director of Educational Centre for "Learning by Doing" Science Education Reform Pilot Program, director of Thinktank: Handsbrain Educaiton. She had got Bachelor of Science of Nanjing Normal University, and Educational Master of Southeast University. She taught physical and physics experiment, and was in charge of managing experimental system from1995 to 2006. Since 2006, she has taken part in the "Learning by Doing" Science Education Reform Pilot Program. She is interested in developing teaching materials and doing related educational research. She has written six books about K-12 science education. From 2007 to 2011, she worked in the team of MOE to revise the national science education standard. She is a national expert of teacher training project organized by M.O.E., China Mainland. She successfully organized national science teacher trainings in the project in 2010, 2011, and 2012.



Progression of Chinese Students' Creative Imagination from Elementary Through High School

Xiuju Li, Fujun Ren

China Research Institute for Science Popularization, Beijing, China Mainland

Dr. Xiuju LI is an assistant professor in China Research Institute for Science Popularization. She received a PhD in science education from Beijing Normal University. Her research interests include science competition, scientific literacy and creativity.

1. Introduction

Imagination is an important skill for scientists and contributes to the development of science (Kind, Permorten & Kind, 2007). When developing new theories, scientists imagine and visualize physical phenomena and play with possible outcomes. Gilbert and Reiner (2000) have shown that this is common practice in science education. Scientific creativity can result from an unconscious, vivid flow of images (Suler, 1980). Based on Vygotsky's theory of creative imagination, both artistic and scientific creativity require the collaboration of imagination and conceptual thinking (Smolucha, L. & Smolucha, 1986). Creative imagination, as both the capacity to imagine possibilities, solutions, and ideas by combining, adapting or developing existing ideas to form new ones and an internal process or mental activity, is characterized by originality, richness, flexibility and profundity. Originality refers to the uniqueness of creative imagination, which is an unusual response to stimulation or one that is different from that commonly given. The more unique the imagination is, the more likely new thinking and views will be generated. Therefore, originality is both a major marker and an essential attribute of creative imagination. Richness refers to the total sum of creative imagination, namely, the amount of creative imagination items in a certain period of time. The more items there are, the faster the response is. Flexibility refers to the ability of creative imagination to meet an emergency, namely, thinking that draws inferences from instances and generates unusual conceptions and new plans. Profundity refers to the meticulousness of creative thinking that makes it more delicate and concrete.

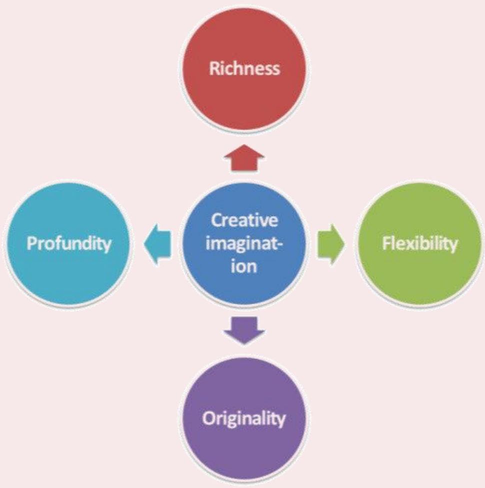


Figure 1 Four Dimensions of Creative Imagination

2. Methods

The authors drew upon the content and approach of creative thinking tests (Torrance & Orlow, 1984; Williams, 1980) in making the TCI. The background questionnaire was developed from a creativity test in China Mainland and England developed by Shen and Peng (2003).

There were 4320 samples nationwide of which 4162 were valid. The data were analysed using SPSS version 16.0.

3. Results and Discussion

The means and standard deviations for scores of creative imagination in different grades are shown in Table 1.

Table 1 means and standard deviations for scores of creative imagination in different grades

Grade		Total Score	Drawing Score	Word Score
Grade 4	M	30.39	24.14	6.25
	SD	8.19	5.71	5.37
Grade 5	M	32.99	24.91	8.08
	SD	9.15	5.89	5.86
Grade 6	M	35.16	25.26	9.90
	SD	9.23	5.94	6.16
Grade 7	M	36.02	25.18	10.84
	SD	9.08	5.64	6.32
Grade 8	M	38.27	25.65	12.62
	SD	9.57	6.12	6.29
Grade 9	M	39.66	25.51	14.15
	SD	9.76	6.59	6.62
Grade 10	M	40.17	26.59	13.58
	SD	9.32	5.85	6.58
Grade 11	M	40.64	26.30	14.34
	SD	8.92	5.96	6.41
Grade 12	M	40.25	26.72	13.53
	SD	8.60	5.90	5.92
Total	M	37.01	25.57	11.44
	SD	9.72	6.00	6.74

A one-way ANOVA for 9 grades was conducted, using the total score of the creative imagination test as the dependent variable. We used least significant difference (LSD) post-hoc comparisons. Results showed that the main effect of grade was significant ($F(8,3075) = 54.633$, $p < 0.05$). There was no significant difference in total score between students from grades 6 and 7 ($p > 0.05$). There was also no statistically significant difference between students from grades 9 and 12 ($p > 0.05$).

There was a statistically significant difference between students in the other grades ($p < 0.05$). Table 1 shows that the total score continued to grow from grade 4 to 11. It reached its peak at grade 11 and began to decline at grade 12. There were two stages of rapid development: from grade 4 to 6 and from grade 7 to 9. From grade 9 to 12, the total score generally remained the same.

Results revealed that creative imagination continued to grow with an increase in grade level, but the pace of development was different at different stages.

Grades 4 through 6 and grades 7 through 9 were two stages of rapid development. Students in these two stages are influenced by both inborn and environmental factors. Students enter adolescence growing very quickly both mentally and physically, which provides a foundation for the rapid growth of creative imagination. Given that students in grades 4 through 6 are in the latter half of their primary education, they are influenced by characteristics of adolescence as well as new teachers, educational activities and increased learning. Therefore, creative imagination of students in this stage develops very rapidly. The rapid development of creative imagination in grades 7 through 9 may have been influenced more by environmental factors such as an increase in subjects, expansion of knowledge, enhancement of presentations, growth of experience and promotion of language skills.

Creative imagination of students in grade 7 was not much higher than that in grade 6, mainly because of environmental factors. Entering junior high school represents a new learning environment, and students must adapt to the changes. Therefore, though creative imagination of students in grade 7 was higher than that in grade 6, the difference was not statistically significant.

Creative imagination of students was generally constant in senior high school, perhaps for the following reason. Adolescence comes to an end for most senior high school students, with rapid mental and physical changes gradually decreasing. Students in grade 12 have completed all courses in the first two years and begin to review in preparation for college entrance examinations. Creative imagination of students in this stage reached its peak at grade 11 and began to drop at grade 12. Because students face the pressure of college entrance examinations in grade 12 and perhaps cared little about the survey, scores for the four dimensions of creative imagination dropped slightly compared to those in grade 11.

Table 1 shows that although the drawing score continued to increase from grade 4 through grade 12, it was still a relatively stable period with respect to the score, with the lowest score in grade 4. The word score continued to increase from grade 4 through grade 12. Grades 9 to 12 represented a period of stable development.

In junior high, a low score on the word test had little effect on the total score of the creative imagination test, but the drawing score played a major role. In senior high, the drawing score did not change much with grade, thus the increased score of the word test directly influenced the total creative imagination score. Thus, the results suggest youths express their imagination in different ways at different stages. Students in lower grades tend to express with drawings, and as they grow up they tend to express with language.

4. Conclusion

This study is a preliminary attempt to identify the progression of Chinese students' creative imagination from elementary through high school. We hope that future empirical studies on improving students' creative imagination will be conducted by interested creativity and science education researchers. Chinese students' creative imagination develops as their grade increases, but the pace of development differs in different stages.

Creative imagination in primary school is lower than that in middle school. It is at the lowest point in grade 4 and reaches its peak in grade 11. Grades 4 through 6 and grades 7 through 9 are two stages of rapid and crucial development in creative imagination. In different grades, youths use different ways to express their imagination. Young students tend to use drawings to express their thoughts, and as they grow up they are good at expressing their imagination with language.

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Alignment between High School Biology Content Standard and Textbooks

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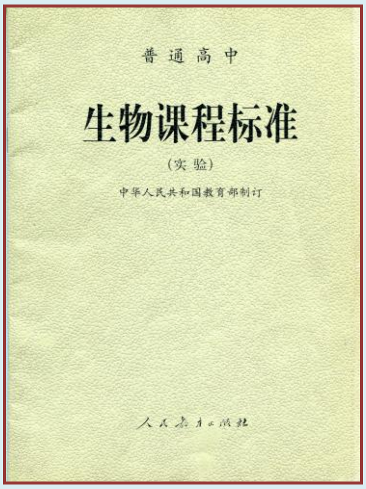
1. Intruduction

The basic education reform in China Mainland launched in 1999 is a national curriculum movement with Enormous influence. Two initiatives of this reform are implementing national content standards in all subjects, and diversifying textbooks under the guidance of national content standards.

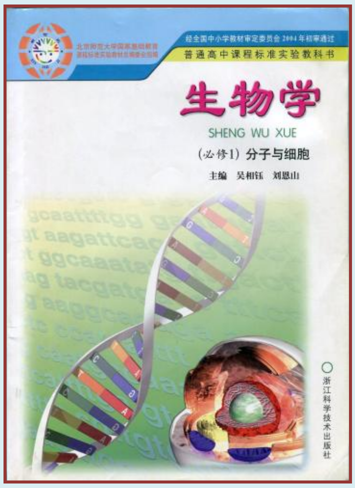
National content standards play a key role in selection of teaching materials, teaching activity and assessment. They are also the cornerstone for managing and evaluating curricula (M.O.E., China Mainland, 2001). Consequently, textbooks should be well aligned with the content standards in various dimensions including the content range, depth of knowledge, content distribution and teaching philosophy as well.

The study is conducted to quantitatively explore the alignment between High School Biology Content Standard (HSBCS) and Biology Textbooks published by People's Education Press (PEP) and Zhejiang Science and Technology Press (ZSTP), using Porter's (2002) two-dimensional alignment method. It is expected to provide research-based evidence for textbook publishers, classroom teaching and policy making.



High School Biology Content Standard

Biology Textbook (PEP)



Biology Textbook (ZSTP)

2. Methodology

2.1 Porter's Alignment Model

In Porter's alignment model, the match of two objects is determined with two criteria: content categories and cognitive complexity level. Standard and textbooks are coded respectively into content by cognitive demand matrices and Porter's alignment index is calculated to indicate the degree of consistency between the two matrices. The operational definition of Porter's alignment index (P) is:

$$P = 1 - \frac{\sum_{i=1}^{n} |(X_i - Y_i)|}{2}$$

Where n denotes the number of cells in the matrix and i is related to one particular cell ranging from 1 to n; X_i represents the i^{th} cell's ratio value of one matrix and Y_i represents the i^{th} cell's ratio value of the other matrix. Further calculation is conducted as the definition formulae require.

Porter's alignment index ranges from 0 to 1.When *P*=0, it means the maximum discrepancy between the two matrices compared. When *P*=1, it means perfect alignment between the two matrices. The index does not have a straightforward interpretation like the proportion of common content between standards and assessments. Nevertheless, the index does make it easy to see whether one set of textbooks are more aligned with content standard than another (Porter 2002).

How high should the alignment index be to claim it is statistically significant? Getting ideas from Professor Xiufeng LIU（2008）and Dr. Gavin W. Fulmer，we used the Unidrnd function of Matlab software to create an algorithm to place randomly 69 objectives in curriculum and 92 (or 104) objectives in textbooks into two tables (9 rows and 6 columns), standardized the values of the tables and calculated the Porter's alignment indices between each pair of tables. Multiple iterations were conducted, generating 20,000 alignment indices, which were mapped out as a normal distribution with mean (l) = 0.545 and standard deviation (SD) = 0.045 (when objectives in textbooks equal 104: l = 0.556, SD = 0.045). Based on the random sampling distribution obtained, an alignment of 0.635 (when objectives in textbooks equal 104, the value is 0.646) is needed in order for it to be statistically significant at the 0.05 level.

2.2 Content Categories and Cognitive Level

The content classification of biology subject in the SEC developed by the Council of Chief State School Officers [CCSSO] (2004) is adopted in this study, which contains nine categories: (1) Components of living systems; (2) Biochemistry; (3) Botany; (4) Animal biology; (5) Human biology; (6) Genetics; (7) Evolution; (8) Reproduction and development; (9) Ecology.

On the other hand, Categories of cognitive reasoning skills are based on the revised 'Bloom's Taxonomy of Educational Objectives' (Anderson and Krathwohl, 2001), which includes 6 levels: remember, understand, apply, analyse, evaluate and create.

The two criteria of classification have been widely accepted and recognized among science education research community.

3. Objectives Coding

3.1 Content standard Objectives Coding

High School Biology Content Standard (HSBCS) (Trial Version) released by the M.O.E., China Mainland in 2003 includes 3 core modules and 3 optional modules. In this study, the specific objectives of 3 core modules are selected to be analyzed. When coding the *HSBCS*, objectives are allocated in particular cells of a content matrix according to their content and cognitive level, and then the total number of objectives in each cell is calculated to produce Table 1. Dividing each cell value in Table 1 by the total number of objectives, we obtained Table 2. The sum of all cell values in Table 2 equals 1.

Table 1 Chinese High School Biology Content Standard based on number of objectives

	Remember	Understand	Apply	Analyze	Evaluate	Create	Subtotal
Components of Living Systems	3	10	2	0	0	0	**15**
Biochemistry	3	4	0	0	0	0	**7**
Botany	1	3	0	0	0	1	**5**
Animal Biology	1	2	0	0	0	0	**3**
Human Biology	1	5	0	0	0	0	**6**
Genetics	3	10	0	2	0	0	**15**
Evolution	0	2	0	0	0	0	**2**
Reproduction and Development	2	4	0	0	0	0	**6**
Ecology	3	5	1	1	0	0	**10**
Subtotal	**17**	**45**	**3**	**3**	**0**	**1**	**69**

Table 2. Chinese High School Biology Content Standard in ratios

	Remember	Understand	Apply	Analyze	Evaluate	Create	Subtotal
Components of Living Systems	0.04	0.14	0.03	0	0	0	**0.22**
Biochemistry	0.04	0.06	0	0	0	0	**0.10**
Botany	0.01	0.04	0	0	0	0.01	**0.07**
Animal Biology	0.01	0.03	0	0	0	0	**0.04**
Human Biology	0.01	0.07	0	0	0	0	**0.09**
Genetics	0.04	0.14	0	0.03	0	0	**0.22**
Evolution	0	0.03	0	0	0	0	**0.03**
Reproduction and Development	0.03	0.06	0	0	0	0	**0.09**
Ecology	0.04	0.07	0.01	0.01	0	0	**0.14**
Subtotal	**0.25**	**0.65**	**0.04**	**0.04**	**0**	**0.01**	**1.00**

Two coders coded the content objectives independently. Inter-rater reliability is calculated with Pearson correlation coefficient 0.962 (n=54, p=0.000), which indicates good inter-rater reliability between the two sets of coding results, the two coders worked together and discussed each objective one by one to produce the final standard table. The subsequent coding of textbooks are also followed this procedure.

3.2 Biology Textbooks Objectives Coding

When coding textbooks, class hours obtained from teacher guidebooks are evenly distributed to cover each objective in these textbooks and then all these objectives are allocated in particular cells of a content matrix according to their content and cognitive level. The total class hours spent on the objectives are showed in Table 3 and Table 4.

Table 3 Textbooks published by PEP based on class hours spent on objectives in ratios

	Remember	Understand	Apply	Analyze	Evaluate	Create	Subtotal
Components of Living Systems	0.09	0.07	0.02	0.01	0	0.01	**0.20**
Biochemistry	0.03	0.05	0	0.01	0	0	**0.09**
Botany	0.02	0.02	0.01	0	0	0.01	**0.06**
Animal Biology	0.01	0.02	0.01	0	0	0	**0.05**
Human Biology	0.01	0.05	0	0	0	0	**0.06**
Genetics	0.07	0.12	0.04	0.01	0	0	**0.24**
Evolution	0	0.04	0.01	0	0	0	**0.05**
Reproduction and Development	0.01	0.04	0	0	0	0	**0.05**
Ecology	0.04	0.08	0.05	0.02	0	0.01	**0.20**
Subtotal	**0.29**	**0.49**	**0.14**	**0.04**	**0**	**0.02**	**1.00**

Table 4 Textbooks published by ZTSP based on class hours spent on objectives in ratios

	Remember	Understand	Apply	Analyze	Evaluate	Create	Subtotal
Components of Living Systems	0.08	0.10	0	0	0	0	**0.17**
Biochemistry	0.03	0.03	0	0	0	0	**0.07**
Botany	0.05	0.04	0.01	0	0	0	**0.10**
Animal Biology	0.03	0.01	0	0	0	0	**0.05**
Human Biology	0.05	0.04	0	0	0	0	**0.09**
Genetics	0.09	0.16	0.01	0	0.01	0	**0.27**
Evolution	0.01	0.03	0	0.01	0	0	**0.05**
Reproduction and Development	0.01	0.02	0	0	0	0	**0.04**
Ecology	0.11	0.05	0.01	0	0	0	**0.17**
Subtotal	**0.46**	**0.49**	**0.03**	**0.01**	**0.01**	**0**	**1.00**

The best fish swim near the bottom.--- John Clark

Good inter-rater reliability between the two coders was indicated by the Pearson correlation coefficient (textbooks published by PEP: 0.886**, n=54，p=0.000; textbooks published by ZSTP: 0.985**, n=54，p=0.000).

4. Results

4.1 The Porter's Alignment Index

The Porter Alignment Index between the content standard and textbooks published by PEP equals 0.739, which is higher than the reference value (0.635, statistically significant at 0.05 level) based on the random sampling distribution. The index between standard and textbooks published by ZSTP equals 0.699, which is also higher than the corresponding reference value (0.646). It shows that both of the two sets of textbooks analyzed in this study are significantly aligned with the *HSBCS*.

4.2 Content Distribution

Based on tables 2-4, Figures 1–3 are mapped out to show content distribution of *HSBCS* and the two sets of textbooks respectively.

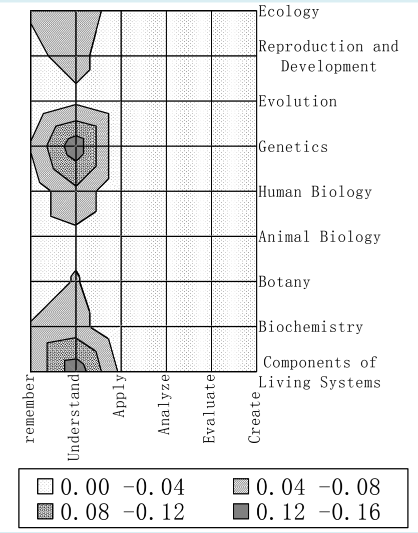


Figure 1: Content distribution of HSBCS

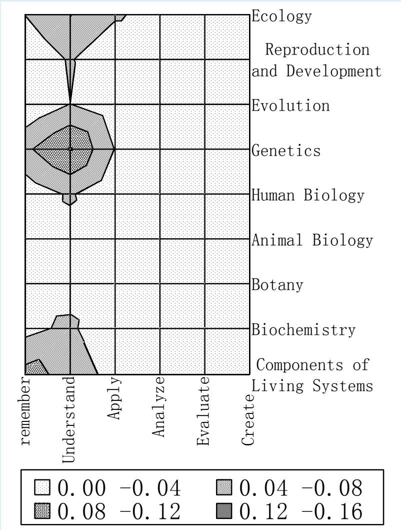


Figure 2: Content distribution of Biology Textbooks published by PEP

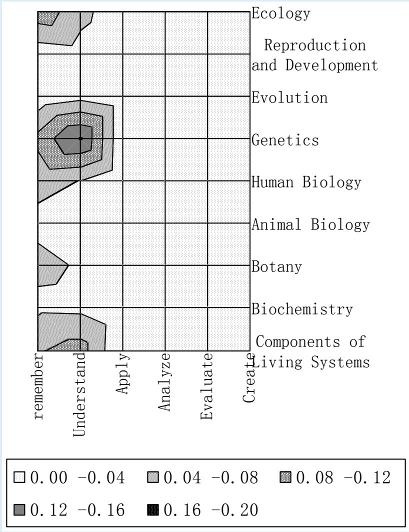


Figure 3: Content distribution of Biology Textbooks published by ZSTP

Topographs are used to represent the results because they can help us to visualize which content category and which cognitive level is focused on in HSBCS as well as Biology Textbooks.

In these topographs, when the intersections of the horizontal lines and the vertical lines are located in the lightly shaded areas (for example, the intersection between 'Evolution' and 'Analyse'), it means that the proportion of the number of objectives in HSBCS or class hours assigned to the objectives in particular content category at the particular cognitive level relative to the total number of objectives or total class hours suggested is no more than 0.04. That is, the lightly shaded area indicates a minimal emphasis. Similarly, the intersections in diagonally shaded areas (for example, the intersection between 'Biochemistry' and 'Understand' in figure 1 and figure 2) correspond to the proportion of 0.04–0.08, which indicates a moderate emphasis. Deductively, the next most heavily shaded area indicates a heavy emphasis (proportion is 0.08–0.12), the most heavily shaded area in Figure 1 (for example the intersection between 'Genetics' and 'Understand' in figure 1) indicates a heavier emphasis (proportion is 0.12–0.16), and the solid black area in Figure 3 indicates the heaviest emphasis (proportion is 0.16–0.20).

Porter's alignment index only uses the total standardized discrepancy. The subtotals of rows and columns are valuable to indicate content distributions and cognitive levels distribution between HSBCS and Biology Textbooks. The information could be mapped out as a histogram (Liu. et al., 2008).

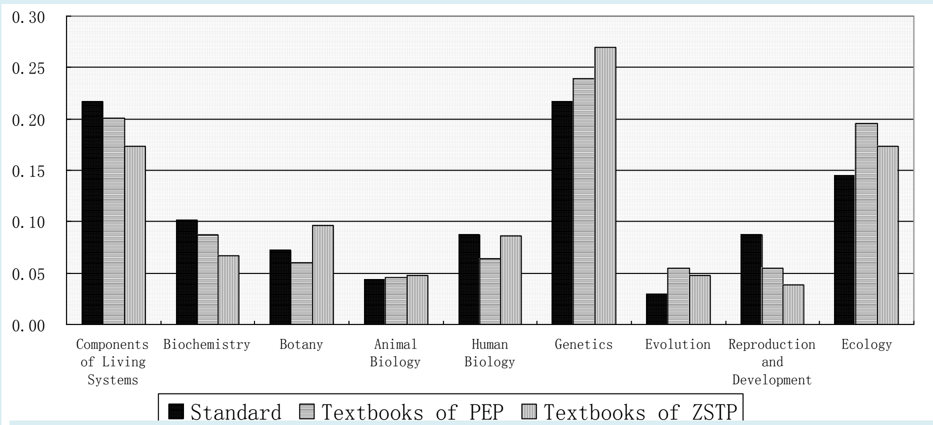


Figure 4. Content distribution of HSBCS and the two sets of Biology Textbooks. The y-axis represents relative emphases among the content categories in percentages.

Figure 4 shows content distribution of HSBCS and the two sets of Biology textbooks analyzed in this study. We can see 3 content categories are the heaviest emphasized by HSBCS and the two sets of Biology Textbooks – 'Components of living systems'; 'Genetics'; and 'Ecology' –which correspond to the main topics of the 3 core modules exactly.

What is more, correlation analysis between HSBCS and Biology Textbooks is performed based on subtotals of rows in tables 2-4. The Pearson correlation coefficient between standard and textbooks published by PEP equals 0.920** (n=9, p=0.000). The Pearson correlation coefficient between standard and textbooks published by ZSTP equals 0.879** (n=9, p=0.001). It indicates that both of PEP and ZSTP Biology Textbooks have high degree of correlation with HSBCS in content category and the correlation between PEP textbooks and HSBCS and the two sets of Biology textbooks is slightly higher than the ZSTP textbooks.

4.3 Cognitive Levels Distribution

Figure 5 shows Cognitive levels distribution of HSBCS and the two sets of Biology Textbooks. From this, we find that standard and textbooks all placed the heaviest emphases on the two basic cognitive skills, 'understand' and 'remember'. However, textbooks published by PEP are more similar to the standard than that by ZSTP in the shape of trend line. In addition, textbooks by PEP placed relatively more emphasis on the higher cognitive skill 'apply', 'analyze' and even 'create'.

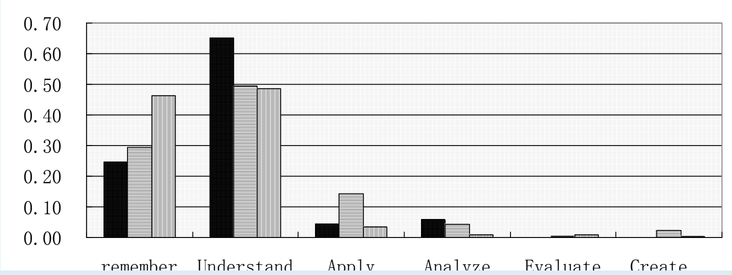


Figure 5. Cognitive levels distribution of HSBCS and the two sets of Biology Textbooks. The y-axis represents relative emphases among the cognitive levels in percentages.

In addition, correlation analysis of HSBCS and text-books by cognitive levels is performed based on subtotals of columns in tables 2-4. The Pearson correlation coefficient between HSBCS and textbooks published by PEP equals 0.961** (n=6, p=0.002). The Pearson correlation coefficient between HSBCS and textbooks published by ZSTP equals 0.883** (n=6, p=0.020). It indicates that both of PEP and ZSTP textbooks have high degree of correlation with HSBCS in cognitive levels and the correlation between PEP textbooks and HSBCS is slightly higher than the ZSTP textbooks.

5. Discussion

In this study, researchers used a quantitative approach to obtain some strong evidence for the alignment between biology textbooks analyzed with HSBCS.

On one hand, based on the alignment between textbooks and standard, teaching activities with the help of textbooks could be more likely to be aligned with the content standard. On the other hand, because of the highly summarized and refined expression in the HSBCS, biology teachers have difficulty in understanding its meaning accurately. Compared with HSBCS, textbooks are much more detailed and easy to be understood. Based on the results, it will be acceptable to a certain extent for biology teachers to seek help from textbooks when interpreting HSBCS.

In comparison of cognitive levels distribution, there is slight difference between the textbooks analyzed and HSBCS. It seems to be easily inferred that students are required to remember the content which is required to be understood in HSBCS. However, it may be attributed to some other factors, such as the different function of the HSBCS and textbooks, the limited number of the objectives analyzed and so on. So far, great efforts are being made to refine and interpret HSBCS, which will facilitate textbook writers to align textbook with HSBCS.

To measure alignment between textbooks and standard, we adopted the porter's two-dimensional alignment model, the widely accepted and recognized criteria of content classification pattern developed by SEC, and cognitive reasoning skills from revised 'Bloom's Taxonomy of Educational Objectives'. This coordinate system could be used in more alignment researches to analyze the consistent relationship between any two factors in the curriculum systems in the future, and will be particularly effective in the national or international comparison. Due to its simplicity, easy-to-use and wide range of applications, this model could also be helpful for science teachers to evaluate whether their teaching activities were aligned with the content standards.

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Instrumentation Development for Measuring High School Students' Understanding of the Core Concepts of Genetics

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1. Introduction

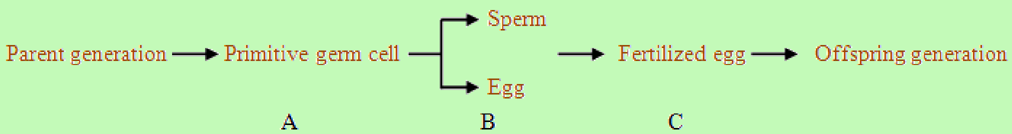
Thoroughly understanding the core concepts of biology is an indispensable element to constitute the bio-science accomplishment. And Genetics is one of the main content themes of middle school biology curriculum. In recent years, the research on the core concept is a popular research field of international science education and High School Biology Curriculum Standard (Trial Version) of China Mainland explicitly puts forward that students shall thoroughly understand the core concepts of biology in the process of solving practical problems (The M.O.E., China Mainland, 2003). Zhang Yingzhi et al. (2010) have finished selecting and presenting the core concepts of Genetics.

In this study, we developed the test paper for examining students' cognitive understanding of the core concepts in Genetics. The test paper is mainly consisted of two-tier multiple choice questions. During test item writing stage, we followed the specific procedures of two-stage development diagnosis test proposed by Treagust (1988). Following this stage, the next step is to do trial test to examine its reliability with Rasch model analysis. After that, we evaluate high school students understanding of the core concepts of Genetics.

2. Methodology

Two-stage diagnosis test paper with 43 items is developed with the guidance of core concepts of Genetics (high school) selected by Zhang Yingzhi et al. In terms of the two-stage development diagnosis test, students is required not only to answer a multiple choice questions on specific subject matter (core concepts), but also to give the reasons or some explanation about their choice. Only both the choice in the 1st stage and the reasons or explanations in the 2nd stage answered correctly cat get the full scores. Otherwise, the answers get score of zero.

For example, in the Genetics theme, "In the sexual reproduction organism, the genetic information transmission from parents to offspring is achieved by male and female gametes" is one of its core concepts. Based on this core concept, a two-tier multiple choice test item is developed as the following.



(1) The above diagram represents the process of generative propagation, the transmitting "bridge" of genes between the parents and their offspring is __________.

A. A B. B C. C D. Have no idea

(2) My reason to choose this option is that:

E. During the meiosis, the genetic information transmits from parents to offspring.

F. Sperm and egg transmit the genetic information from the parents to the offspring.

G. Fertilized egg is the starting point of the life development, transmitting the genetic information from parents to offspring.

H. The transmission of genetic information is carried out through meiosis.

I. Other reasons______________________.

3. Results and Analysis

3.1 Parameters about the Measurement Tool

In Rasch measurement model, the measurement reliability is usually embodied by these indexes such as standard error, items and separation degree of tested objects, items and reliability of tested objects (Millar, R., & Hames, V., 2006). Being analyzed with Rasch measurement model, the test paper shows the standard error, separation degree and reliability of the tested objects with 0.39, 1.26 and 0.61 respectively, and the standard error, separation degree and reliability of the items with 0.22, 6.31 and 0.9 respectively. The error of tested objects is relatively large while the separation degree is relatively small.

The measurement validity can be analyzed from Wright diagram, items-model matching and one-dimensional test (Millar, R., & Hames, V., 2006).

Wright diagram puts the items and the tested objects on the same measuring scale according to the level of difficulty and ability, intuitively and visually displaying the corresponding relation between the items and the tested objects and the distribution of both on the measured variable (Fig. 1)

From the overall distribution of the items, we can see that the difficulty degree of 43 items is relatively wide and basically in homodisperse without suffering the phenomenon of "getting together". The distribution of students' ability is relatively ideal with certain dispersion span; students are relatively concentrated in the central part while students in the high and low ends are relatively fewer. However, as for the tested samples, this test paper appears relatively easy and the ability of most students is higher than the average value of the item difficulty. As for the items with relatively small difficulty (such as S17 and S2), most students can correctly answer them, so their identification effect is relatively limited. Besides, S19-S38 exist relatively large interval and the students in this section have no items to correspond with them. In the next step, it is proper to reduce the items with relatively small difficulty to better test the students with higher ability. Meanwhile, the tested objects with low level should be increased to make the distribution scope of students' ability wider, and which will be identified easily by the items with relatively small difficulty. All these further research will help the researchers to get properly designed items that filling relatively large intervals.

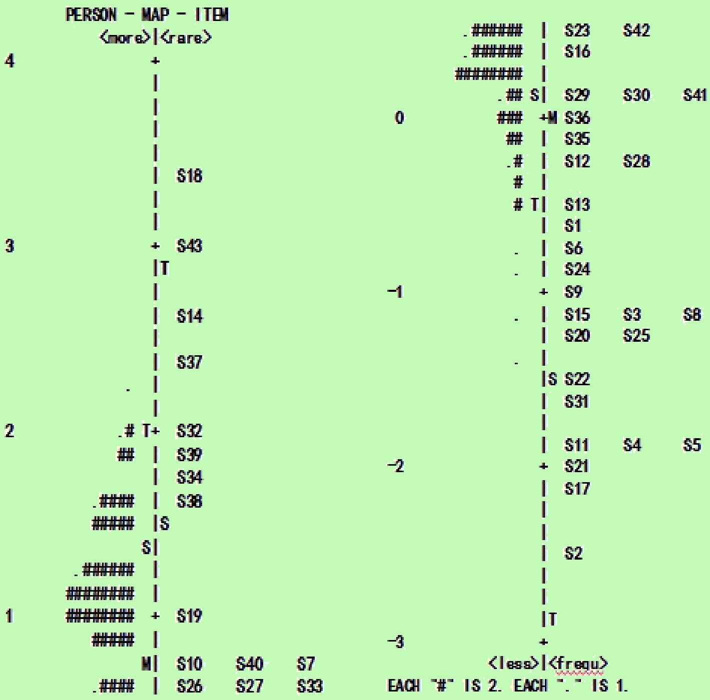


Fig. 1 Wright diagram of Tested objects-items relation of the test paper on the core concepts of Genetics
(Note: each # in the diagram stands for 2 students, each stands for 1 student and S stands for the choice questions. Similarly hereafter)

As for item-model matching, MNSQ in the overall matching index Infit and Outfit is 1 while ZSTD is 0 and the matching condition is ideal（Wei Silin, 2010）. The ZSTD of S10 and S42 exceeds -2~2 while that of other questions is all in -2~2, which shows that most questions in the test paper can match the expected model well（Wei Silin, 2010）. In the next step, items S10 and S42 should be modified so as to fit for Rasch model.

As for the one-dimensional test, the test items lying in the related coefficient of -0.4~0.4 shows they measure the same structure（Wei Silin, 2010）. Items S3, S10, S31 and S35 in this test paper exceed this scope while that of other items lies in -0.4~0.4, which shows the overwhelming majority of items measure the same psychological traits with one-dimensionality. Generally, the developed measurement tool is of fine reliability and validity of measurement. According to the results of preliminary survey, delete S2 and S5 and further modify and perfect the items that do not accord with the requirement, formulate and finish the diagnosis test paper on the core concepts of Genetics, formally test and discuss the students' understanding of the core concepts of Genetics.

3.2 High School Students' Understandings about Genetics

Research result shows that high school students participated in this study understand and master the following five core concepts very well:

- One hereditable character can be decided by one or more genes.
- The character of filial generation depends on the combination of dominant and recessive alleles.
- DNA is the important hereditary substance.
- The separation and free combination of genes in generative propagation make the genotype and phenotype of the filial generation have various possibilities and it can forecast the inheritable character of filial generation through this, and
- DNA molecule is the long chain constituted by four kinds of macromolecules (deoxynucleotide) with two reverse parallel long chains forming double helix structures.

But they cannot thoroughly understand the following core concepts in Genetics:

- DNA molecules make use of template mechanism to copy.
- The gene variation caused by mutation and recombination is the source of evolution.
- Genetic engineering changes the organism by regulating and controlling the genes, and
- The cell differentiation is nearly always because the gene expression model is different but not because the gene itself is different.

These concepts may become the challenging content that can arouse students' interest in thinking and through study in the teaching process.

The other ten core concepts have no great challenges to the learning of senior high students, which is the condition of their understanding and cognition, showing if the students are provided with proper learning situation, they can understand the contents of the ten sides very well.

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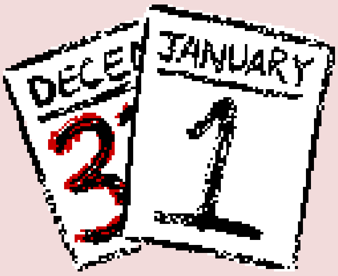

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  http://www.ase.org.uk/conferences/annual-conference/
- **ASTE 2013International Conference, Jan. 9-12, 2013 @ Charleston, USA**
  http://theaste.org/meetings/2013conference/
- **AAAS Annual Meetings, Feb. 14-18, 2013 @ Boston, USA**
  http://www.aaas.org/meetings/future_mtgs/
- **The International Conference New Perspectives in Science Education Second Edition, Mar. 14 – 15, 2013 @ Florence, Italy**
  http://www.pixel-online.net/npse2013/
- **245th ACS National Meeting & Exposition, Apr. 7-11, 2013 @ New Orleans, USA**
  http://portal.acs.org/portal/acs/corg/content
- **2013 NARST Annual International Conference, Apr. 6-9, 2013 @Rio Grande, Puerto Rico**
  http://www.narst.org/annualconference/2013conference.cfm
- **NSTA 2013 National Conference, Apr. 11–14, 2013 @ San Antonio, USA**
  http://www.nsta.org/conferences/2013san/
- **The 7th World Congress of Environmental Education (WEEC), June 9 -14, 2013 @ Marrakech (Morocco)**
  http://www.weec2013.org/en/
- **The IHPST biennial Conference, June 19-23, 2013 @Pittsburgh, PA, USA**
  http://ihpst.net/
- **ASERA Conference 2013, Jul. 2-5, 2013 @Te Papa Tongarewa Wellington, New Zealand**
  http://www.nzcer.org.nz/asera-2013
- **EASE 2013 Conference. Jul. 4-6, 2013 @ Hong Kong**
  http://ses.web.ied.edu.hk/ease2013/
- **ESERA Conference 2013, Sept. 2-5 @ Nicosia, Cyprus**
  http://www.esera2013.org.cy/nqcontent.cfm?a_id=1
- **ICASE 2013 Borneo. Sep. 29 - Oct. 3, 2013. Kuching City, Sarawak, Malaysia**
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The beginning is the most important part of the work.--- Plato