E·A·S·E
East-Asian Association for Science Education

The Newsletter of
The East-Asian Association for Science Education
東亞科學教育學會通訊
http://theease.org

Vol.7, No.1
No. 0025
March. 31, 2014

Beijing Normal University
No.19, Xinjiekouwai Street
Beijing, China
+86-10-58805062
Fax: +86-10-58802075

Research on core chemical idea learning progressions and key competence development in secondary school: based on cognitive mode development theory and by using Rasch model

Lei wang[1] Yao Zhi[2] Boyuan yin[2] Mingchun Huang[1] linazhang[1]

1 Beijing Normal University

2 Teachers' Training School of Beijing Haidian District

Corresponding Email: wangleibnu@126.com

Abstract: The symposium focuses on two parts. One is a research framework on learning progressions from the perspective of chemical cognitive mode development theory which brought up from the research team in Beijing Normal University Institute of Chemical Education guided by professor Lei Wang. The other are four case studies on the progressions of chemistry learning in secondary school, which are (a) Research on Organic Compounds' Learning Progression in Senior Secondary School from the Perspective of Chemical Cognitive Mode (Yao Zhi); (b) Research on Electrolyte solution's learning progressions in secondary school (Boyuan Yin); (c) Development of a Learning Progression for the structure of Matter in secondary school (Mingchun Huang); and (d) Evaluation on Junior Secondary School Students' Learning Progression of Chemical Change(Lina Zhang).

Key words: cognitive mode development theory, Rasch model, learning progressions

1 Introduction

Science educators have started to explore learning progressions (LPs) as a means for understanding how students develop their knowledge of complex science content over time (Merritt & Krajcik, 2012). The development of LPs in science education include science core ideas, skills and practice. Recently, LPs has been discussed as a promising tool for designing a coherent science curriculum (Smith, et al.,2006; Duschl, Schweingruber &S house, 2007). The research results of LP are highly valuable to learning, curriculum, instruction and evaluation.

The research about students learning and development guided by professor Lei Wang has been lasted for almost ten years. Instead of exploring what kind of misconceptions that secondary school students have, researchers pay more attention to describe the level and progressions of students' concepts, as well as mechanism which can influence and regulate students' misconceptions. By reference to LPs research and doing research practice successively, the research team gradually constructed the cognitive mode development theory which concerns about students' concepts development and regulatory mechanism. Since HongXiao (2005), the team keeps exploring the core elements which can influence students understanding. Yao Zhi (2011) complete the theory model of cognitive mode development theory which includes chemical cognitive mode model and cognitive mode development level model.

The team's researches involve research on core ideas and key competences. Core ideas includes matter, reaction and energy, such as: Inorganic elements and compounds (Cheng Pan,2010); Chemical equilibrium and reaction rate (Ying Zhang,2009); Primary cell (Tao Jiang2010). Competence including chemical inquiry (Dongfang Liu, 2012), and chemical reasoning (Qiong Huang, 2012). The research results can describe the characteristics of students' learning in different grade span, and the cognitive mode model has been proved to be validated. Meanwhile the results have been used to evaluate textbooks and curriculum design.

The symposium focuses on two parts. One is a research framework on learning progressions from the perspective of Chemical cognitive mode development theory which brought up from the team in Beijing Normal University Institute of Chemical Education guided by professor Lei Wang. The other are four case studies on the progressions of chemistry learning in secondary school, which are (a) Research on Organic Compounds' Learning Progression in Senior Secondary School from the Perspective of Chemical Cognitive Mode (Yao Zhi); (b) esearch on Electrolyte solution's learning progressions in secondary school (Boyuan Yin); (c) dvelopment of a Learning Progression for the structure of Matter in secondary school (Mingchun Huang); and (d) Evaluation on Junior Secondary School Students' Learning Progression of Chemical Change (Lina Zhang).

2 Research Framework

Research in learning progressions has emerged since the study of misconception. The existed researches attempt to generalize the conceptual change mode so that a cognitive model can be constructed. It can be valuable in curriculum, instruction and assessment system, because it added the evidence that can show the development of students. But, the way to describe LPs lies in either concept or performance, it lack of portray both sides. And, most of them cannot tell us what is the key factor that make students move from level 1 to level 2, and how to make it move upwards?

The existing researches on cognitive structure have already brought up their thinking of solving the problem of knowledge transforming into competence. But it pay more attention on describing the results when finishing learning than the function or the route of knowledge， and it seems to be too general to fit for different domain of science. In area of research on cognitive structure, the research on conception framework aims to solve the problem of knowledge transformation. It has a firm connection on knowledge. It uses conceptions, as well as levels of conceptions to describe the difference in students' development. However, it lack of illustration both for the function of knowledge and for the thinking route. Also, mental model theory was an influential theory on exploring the individual cognition. It emphases on specific knowledge of individual more than the relationship among them, that makes it not so structural. In description of ideal and factual, it lays more weight on the latter. In that case, we believe that research on mental model is more functional in explain difference individually， But it is not structural enough to describe ideal as well as reality.

In order to explain the transformation from knowledge to competence which neither too generally nor too specifically, we construct a research framework which called cognitive mode development theory. Cognitive mode is an interior factor influences specific concept learning and student's cognition about specific topic and content domain. It is a kind of thinking model or perspective which is used in conceptual understanding and problem solving (Wang Lei *et al*, 2002). The whole theory has its own framework which shows the mode of cognition and reasoning using by student when analyzing phenomena, solving problems and understanding ideas of specific domain. Such cognitive mode can be illustrated by the following cognitive variables (Figure 1), (1) cognitive perspective, (2) reasoning path (the relationship of perspectives), (3) cognitive pattern. Those are three components of the cognitive mode. Here is a figure of the cognitive mode development theory.

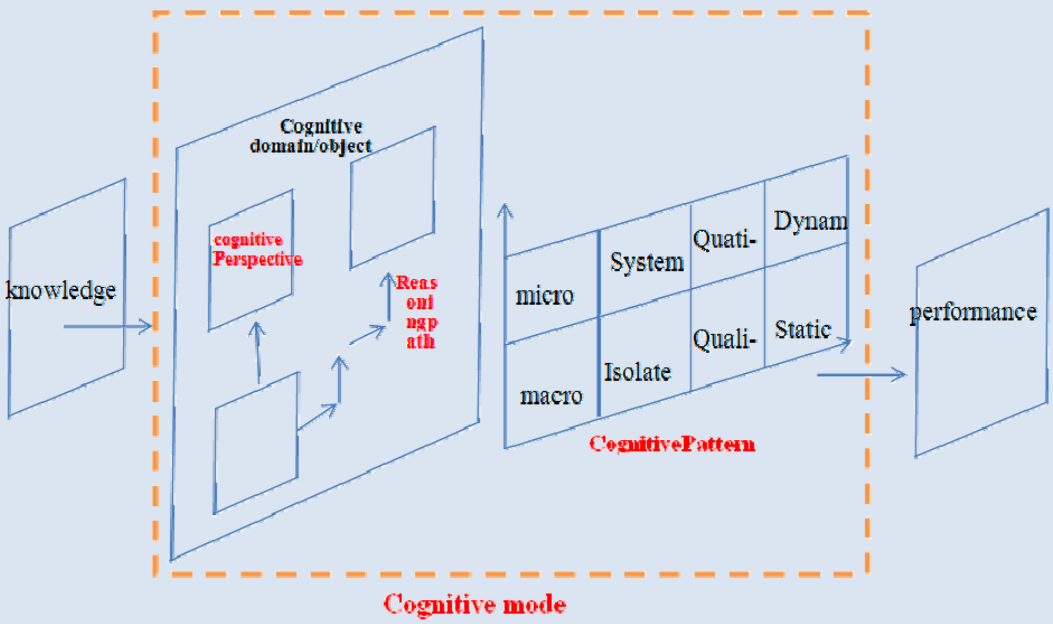


Figure 1 explanation of the cognitive mode development theory

In this framework, there are some variables need to be explained. **Cognitive Perspectives** means the special points of view or lens which is used by student to understand ideas, analyze phenomena and solving problem, they are different with different cognitive object and domain. **Reasoning path** is the route and process of reasoning, usually reflected by the relationship of perspectives. **Cognitive pattern** is generally classified with macroscopic/microscopic, qualitative/quantitative, isolated/systematic, and static/dynamic (Wang Lei *et al.*, 2005, 2009, 2010). Cognition domain and object refers to the chemistry content or topic, for example, Solution/Matter/Organic Compound/ Chemical. Performance means tasks such as describing, illustrating, explaining, predicting, and designing.

Here is an example to illustrate the meaning of those variables. It shows students' response when facing a task.

Teacher: Predict the chemical properties of SO_2, explain your basis (students have already learned the concept of redox reaction)

Student 1: It can react with Sodium hydroxide, because it seems to be similar with CO2.

Student 2: It can react with base because it is acidic oxides

Student 3: From the valence of S, we can predict it can show property of oxidation and reduction.

Student 4: It is acidic oxides so that it can react with base, meanwhile, the valence of S is +4, so it can react with both oxidants and reductants.

When analyzing students' difference from the perspective of Chemical cognitive mode development theory, we can generalize three types of perspectives to one performance existed in different students: matter, matter classification and valence—that is what we called **cognitive perspective**. Meanwhile, we can also find some students are more macro and isolated (CO_2), others are micro and system—that is what we called **cognitive pattern.** those two factors construct a structural mode which shows different levels, we called the mode cognitive mode and its development in inorganic compounds domain.

Through the whole cognitive mode development framework, students' differences and development in learning can be characterized. They are reflected by the amount and the level of Perspectives of cognition, cognitive pattern as well as level of performance. So, the learning progression of specific domain or topic can be described by the development of domain-specific cognitive mode of student. Also, we can explore the learning progressions of core chemical idea by assessing the development of domain-specified Cognitive Mode.

The development of domain-specific cognitive mode of student may be related with grade\curriculum\content knowledge, but not definitely. It is decided mostly by the transformation from knowledge to cognitive mode, so the cognitive mode development framework is sensible to teaching.

3 Methodology

The common procedure of research from the perspective of cognitive mode development theory includes two stages. Firstly researchers developed a cognitive mode model which aims at revealing mechanism influenced learning. Researchers need to unpack the core idea, extract the key elements by analyzing subject matter, test paper and literature about learning, so as to construct the cognitive mode model which serves as a Hypothetical Learning Progression. Then by collecting the data of students' performance, researchers can build cognitive mode development model. In this step, we will review on misconceptions and interview students to write test items, and make scoring rubric by field test results. Questionnaire will be followed to get the evidence of students' performance. Finally, test items will be revised and development levels will be generalized by data analysis based on Rasch model.

3.1 Procedure of Research from the Perspective of Cognitive Mode theory

The common design of research from the perspective of cognitive mode theory include: (a) building the model of specific domain cognitive mode by interview, content analysis and mental simulation for cognitive activity. (b) constructing LPs assessment framework. (c) developing instrument based on Rasch model. (d) survey and revising the cognitive mode and instrument. And (e) identifying the levels of learning progressions.

3.2 Specific methods of Research from the Perspective of Cognitive Mode theory

Method that leads to each procedure of research from the Perspective of Cognitive Mode theory includes:

1. Semi-structured interview. 2. Think-aloud tasks. 3. Text analysis of science education documents and textbooks. 4. Develop the measurement instrument based on Rasch model. 5. Item type usually includes two-tier multiple choice items, multiple choice items, concept mapping items, and 5-point Kikert scale. And 6. Large scale survey.

3.3 Data Analysis——Rasch model from the Perspective of Cognitive Mode theory

The reasons why choosing Rasch model as the data analysis tool lay in:

1. Rasch model describes a measurement theory – an ideal scenario about examinees' performances on a test.
2. When data fits with the Rasch model, measures possess unique properties.
3. The objective of Rasch model is to construct items and the measurement instrument so that the data produced can fit with Rasch model.
4. It is a theory-based cyclic process – conceptually different from statistical reasoning.

4 Conclusion

The whole symposium brings up and proves a research framework on learning progressions from the perspective of chemical cognitive mode development theory. Four case studies is provided.

4.1 Conclusions in Research on the Learning Progressions of Organic Compounds in Secondary School

From the research, we can conclude that:

1. The learning progression of organic compounds are divided into 5 levels:

L1: Macro–isolated, L2: Submicro-isolated, L3: Micro-isolated, L4: Submicro-system, and L5: Micro-system.

In the learning progression of organic compounds, the key cognitive perspectives are "functional group" and "chemical bond", the key cognitive pattern is "system".

2. After learning the compulsory curriculum, most students were able to recognize the composition of organic compounds based on physical matter and facts. After learning the optional curriculum, some students are able to recognize the composition, structure and properties of organic compounds based on functional group, while others are able to know the bonding pattern of organic compounds based on shared electrons.

3. It can be seen from the perspective of chemical cognitive style that students' cognitive progression is mainly manifested as a rich variety of cognitive perspectives (from the composition to the composition, structure and properties) and a change in cognitive style types (from macro-isolated to submicroscopic-systematic or microcosmic-isolated).

4. Teacher's teaching activity have an important effect on students' chemical cognitive style. However, when a certain chemical cognitive style in the textbook has become a key clue that runs through a theme and there is practical experience, textbooks will become the major factor influencing the construction and development of students' chemical cognitive style.

4.2 Conclusions in Research on Electrolyte Solution's Learning Progressions in Secondary School

From the research, we can conclude that:

1. The learning progressions of organic compounds can be categorized into 5 levels:

L1: Do not consider interactions, L2: Focus on complete ionization only, L3: Focus on single equilibrium, L4: Consider the interaction between equilibriums, and L5: Focus on the primary and secondary of equilibriums.

Learning progressions of students in different schools are different, the level increases with grade as a whole, but for some students, even if they have learned the conception in grade 12, they fail to reach level 4.

2. In a lower level, the understanding of interaction of particles could be most important. Students who can comprehend complex interaction in electrolyte solution perform better in other cognitive perspectives such as species of particle. Lacking of deep understanding of interaction can be the major reason that students make mistakes in solving electrolyte solution problems. But

in a higher level, a single concentrate on interaction is not enough. Students need multi-perspectives reasoning ability and systematical analysis ability to solving problems. And lacking of these abilities may limit students' further development.

4.3 Conclusions in Development of learning progressions for the Structure of Matter in secondary school

From the research, we can conclude that:

1. The learning progression of organic compounds includes 9 levels:

L1: element, L2: particle, L3: Atom-motion, L4: Outermost electron－shell-Interaction, L5: Electron－shell-Electrostatic attraction, L6: Charge distribution - static equilibrium -molecular configuration, L7: Localized orbitals – electrostatic repulsion (VB) - molecular polarity, L8: Delocalized orbitals - orbit Restructuring - dipole (odds), and L9: Quantum - wave function - molecular orbital.

2. Most grade 9 students are located in level 1\2\3, and students of grade 10 are located in level 3\4\5. Students in grade 11 increased to level 4/6/7. Level 5 is a little bit weak for students. Most students in grade 11 can use concept of orbital, while in a localized way. The idea of quantum theory，such as probability, wave function, energy quantization，don't come into their minds when solving problems. If the structure of matter is too particle, students can hardly understanding the wave nature of it. Level 4 is most frequent level, which means octet rule influence students' cognition the most.

4.4 Conclusions in Assessment on Junior Secondary School Students' Learning Progressions of Chemical Change

From the research, we can conclude that:

1. Students' learning progressions of chemical change after instruction in junior secondary school can be categorized into 3 levels: Recognizing, Understanding, Reasoning.

2. The factors influencing students' learning progressions lay in cognitive perspectives, patterns, and knowledge.

References

1. National Research Council (2012). Framework for K-12 science education: Practices, cross-cutting concepts, and core ideas. H. Quinn, H. Schweingruber, and T. Keller (Eds.), Washington, DC: National Academies Press.

2. Stevens, S.Y., Delgado, C., & Krajcik, J. (2010). Developing a hypothetical multi-dimensional learning progression for the nature of matter. *Journal of Research in Science Teaching*, 47(6), 687-715.

3. Xiufeng Liu, Kathleen M. (2006). Progression in Children's Understanding of the Matter Concept from Elementary to High School. *Journal of Research in Science Teaching*. 43(3), 320-347.

4. Carol L. Smith, Marianne Wiser, Charles W. Anderson, Joseph Krajcik. (2006). Implications of Research on Children's Learning for Standards and Assessment: A Proposed Learning Progression for Matter and the Atomic-Molecular Theory *Measurement*, 14(1&2), 1-98.

5. Xiao Hong. Study on the Style of High School Students' Understanding Chemistry Conceptions. Unpublished doctoral dissertation, Beijng, Beijing Normal University. 2004.

6. Carol L. Smith, Marianne Wiser, Charles W. Anderson，Joseph Krajcik. Implications of Research on Children's Learning for Standards and Assessment: A Proposed Learning Progression for Matter and the Atomic-Molecular Theory. *Measurement*, 14(1&2), 1-98.

7. Xiufeng Liu. Using and Developing Measurement Instruments in Science Education: Printed in the United States of America：2010 IAP －information Age Publishing, 2010. 206-208,

8. Wilson, M. (2009). Measuring progressions: Assessment structures underlying a learning progression. *Journal of Research in Science Teaching*, 46(6), 716-730.

9. Merritt, J. (2010) Tracking students' understanding of the particle nature of matter. Unpublished doctoral dissertation, University of Michigan, Ann Arbor, MI.

10. Liu, X., & Lesniak, K. (2006). Progression in children's understanding of the matter concept from elementary to high school. *Journal of Research in Science Teaching*, 43(3), 320-347.

You are welcome to distribute this newsletter to your colleagues and students. But do not use portraits and logos without permission.

Development of a Learning Progression for the structure of Matter in Secondary School: based on Cognitive Mode Development Theory and by Using CCD Model

Mingchun Huang (Beijing Normal University)
Email: hmc91810@126.com

Abstract: The research aims at developing a learning progression for the structure of matter in secondary school from grade 9 to 12 in China Mainland. Based on Construct-Centered Design, a construct which made up of concept, performance and cognitive perspective has been built. Also, the learning progressions' development procedure has been guided. By large sample survey, 9 levels of structure of matter have been determined, which are: Level 1: substance – elements; Level 2: particle - particle motion; Level 3: atom – valence; Level 4: the valence electron - bond (8 e-); Level 5: valence electrons offset - electrostatic attraction; Level 6: static balance - intermolecular interaction; Level 7: Bohr orbit - electrostatic repulsion - molecular structure; Level 8: probability - electron delocalization – dipole; and Level 9: quantum - wave function - molecular orbital.

Key words: learning progressions, cognitive perspective, Construct-Centered Design, the structure of matter, secondary school

1 Introduction

Learning progression has drawn on peoples' attentions since the publication of A framework for k-12 science education: Practices, Crosscutting Concepts, and Core Ideas in 2011. Although it has no precise definition among science education research area, researchers believe that the research-based descriptions of learning progression lies in a potential path on which students may progress from less to more expert understanding of a big idea over a defined period of time. Many research groups show their work in learning progressions. AAAS strand maps is a presentation of learning progressions, it created them that suggest a logical sequence of ideas for building understanding within a given topic (AAAS, 2001). BEAR Assessment System (Wilson, et. al., 2005) uses progress variables to develop learning progressions, progress variables are representations of the knowledge, skills, and other competencies that could be improved through the learning activities associated with a curriculum. Since people realize that learning progressions can be a useful evidence to organize curriculum (and standards) around a smaller number of big ideas (Smith et al. 2006), it becomes popular in science educational research area.

Recently, many learning progressions have been developed using different model. Some learning progressions describe student development regarding understanding of a science topic in different discipline, (Catley, Lehrer, & Reiser, 2004; Duncan, Rogat, & Yarden, 2009; Roseman, Caldwell, Gogos, & Kurth 2006; Mohan, Chen, & Anderson, 2009; Alonzo & Steedle, 2009 ; Steedle & Shavelson 2009; Plummer&Krajcik ，2010；Plummer&Slagle ，2009; Lee&Liu ，2010; Songer，Kelcey，&Gotwals, 2009). In this area, There are many researches that focus on learning progressions of matter (see table 1). Others describe development of domain-general scientific practices and skill (Berland & McNeil, 2010; Sikorski, Winters, & Hammer, 2009; Schwarz et al, 2009). These learning progressions describe student learning as an ongoing process that starts with students' most naive ideas and leads toward scientific understanding or practice. In all these works for learning progressions, there are some typical paradigm to develop it, such as BEAR (Wilson & Sloane, 2000); ChemQuery (Jennifer claesgens, 2007); CCD (Namsoo Shin, Shawn Y. Stevens, Harry Short & Joseph Krajcik, 2009); Facets approach (Kevin D. Cunninham, 2010).

In China Mainland, many science educators pay much more attention to students' development too (Lei Wang, 2005-2013; Enshan Liu, 2009; Zuhao Wang, 2010). The researches in Beijing Normal University Institute of Chemical Education guided by professor Lei Wang focused on students learning and development for almost ten years. Their work even expands to curriculum design and instruction using students' developing level as evidence.

Our work builds on and expands their previous studies. In particular, we seek to develop a learning progression that unveils the successively more sophisticated ways of thinking about the structure of matter across the middle school, obliged high school and elective high school by using Construct-Centered Design. And by doing so, we build construct map from the perspective of cognitive mode development theory firstly.

Research questions are:

1. What's the construct map of the "learning progressions in structure of matter"?

2. How does students' construct map of Structure of Matter grow from junior secondary school through senior secondary school?

Table 1 Existing research about learning progressions of substance

Author	Title	Topic	Grade
Liu, X, & Lesniak, K. (2005)	Students' progression of understanding the matter concept from elementary to high school	The matter	3rd and 4th 、7th、8th and 12th
Smith, Wiser, Anderson, & Krajcik, (2006)	Implications of research on children's learning for standards and assessment: A proposed learning progression for matter and the atomic molecular theory	Matter and the atomic molecular theory	K-8
Shawn Y. Stevens, *et al.* (2007)	Developing a Learning Progression for the Nature of Matter as it Relates to Nanoscience	Nanoscience	Middle, high school & undergraduates
Jennifer Claesgens. et al (2008)	Mapping Student Understanding in Chemistry: The Perspectives of Chemists	Matter	high school & university
JoiD. Merritt, et al（2008）	Development of a Learning Progression for the Particle Model of Matter	Particle Model of Matter	6th-grade
Eun Jung Park *et al.*, (2009)	Understanding learning progression in student conceptualization of atomic structure by variation theory for learning	Atomic Structure	university
Marianne Wiser, *et al.* (2009)	Developing and Refining a Learning Progression for Matter: The Inquiry Project: Grades 3-5	Matter	Grades 3-5
Shawn Y. Stevens, *et al.* (2010)	Developing a Hypothetical Multi-Dimensional Learning Progression for the Nature of Matter	Atomic structure and inter-atomic interactions.	grade 7–14
Philip Johnson *et al.* (2011)	The Emergence of a Learning Progression in Middle School Chemistry	substance	ages 11–14

2 Research framework

In this research, we built a theoretical model which can show our research objectives and the components of construct map using in developing learning progressions of Structure of Matter from junior secondary school through senior secondary school. (see figure 1)

In this model, there are three dimensions of construct map, which are concept, performance and cognitive perspective. The definitions of them are:

Cognitive perspective: in domain of SM, cognitive perspective is included.

Performance: use verbs, such as identify/describe, compare/interpretation, explanation, prediction to illustrate to show what kind of task students can finish.

Core concept: in domain of SM, core concept includes concepts which are related to atom structure, molecular structure, and structure-property relation.

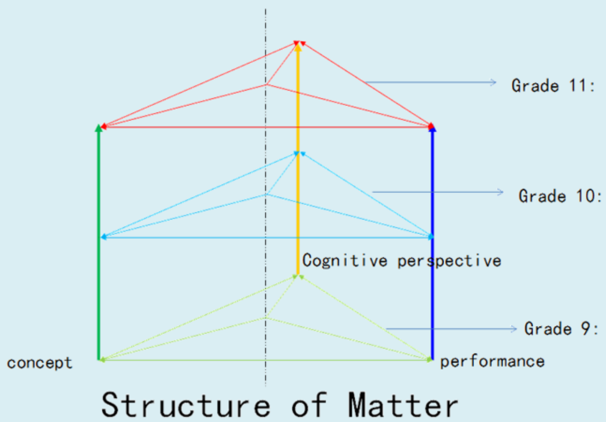


Figure 1 theoretical model of the research

Here is an example to illustrate what is cognitive perspective. It shows students' response when facing a task,

Teacher: Explain the reason that sulfur and sodium react to produce a ionic compounds.

Grade 11: Compulsory Curriculum

Student 1: element sulfur is non-metallic, sodium is metal.

Student 2: in order to obey the octet rule, sulfur atom gains electrons, a sodium atom loses electrons.

Student 3: ...through ionic bonds, Sodium cation and sulfide anion sodium form ionic compound.

Grade 12: Optional Curriculum

Student 4: the electrostatic interaction between a large number of ions in solid sodium sulfide causes them to form an ionic compound.

Student 5: sodium and sulfur the electronegativity difference between sodium and sulfur is greater than 1.7, and thus the formation of an ionic compound.

When analyzing the difference among students' response from the perspective of Chemical cognitive mode development theory, we can generalize five types of perspective to one performance and one concept existed in different students: element, electron, bond, electrostatic interaction, electronegativity——that is what we want add in: we called them cognitive perspectives, they belongs to different levels.

3 Methods

The whole procedure of developing learning progressions for the structure of matter in secondary school is based on Construct-Centered Design. By analysis 154 international science education standards (science, physical, chemistry) statistically (sentence by sentence), the Testing Instruments framework has been developed. The instrument was pilot-tested with a small sample (about 100), then administered to a sample of 528 students from grade 9 to 11 in March 2013. Students in each grade have finished learning the content of the structure of matter. Winstep which is based on Rasch model has been used for the data analysis.

According to Construct-Centered Design model, we have to select construct first. In this research, we select construct map as concept, performance and cognitive perspective.

Then we Create claims by international curriculum standards analysis, the analyze framework lie below (see figure 2).

The third step is to develop the hypothetical learning progressions, which includes 9 levels: Level 1: substance – elements; Level 2: particle - particle motion; Level 3: atom – valence; Level 4: the valence electron - bond (8 e-); Level 5: valence electrons offset - electrostatic attraction; Level 6: static balance - intermolecular interaction; Level 7: Bohr orbit - electrostatic repulsion - molecular structure; Level 8: probability - electron delocalization – dipole; Level 9: quantum - wave function - molecular orbital.

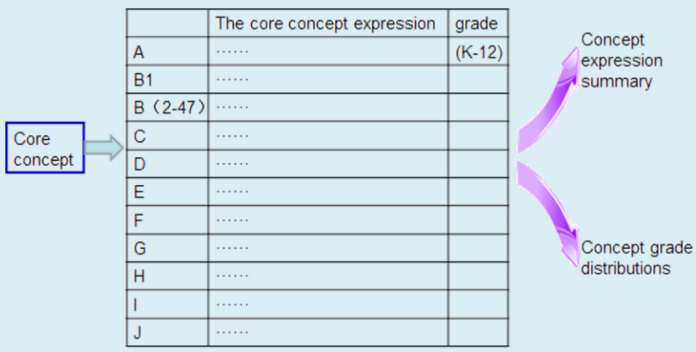


Figure 2 international curriculum standards analyze framework

The fourth step is to develop assessment instrument according to the results of international curriculum standards analysis.

Finally, administer the test in large scale sample. The instrument reliability is showed in figure 3.

```
--------------------------------------------------------------------------------
| PERSON     528 INPUT     528 MEASURED                  INFIT         OUTFIT   |
|            TOTAL       COUNT      MEASURE  REALSE     IMNSQ   ZSTD  OMNSQ   ZSTD|
| MEAN       112.4        25.2        -1.24     .24      1.15    -.6    .88   -1.3|
| S.D.        50.6         4.0          .81     .09      1.13    3.1    .95    2.5|
| REAL RMSE    .26 TRUE SD     .77  SEPARATION  3.03  PERSON RELIABILITY  .90|
|-------------------------------------------------------------------------------|
| ITEM        65 INPUT      65 MEASURED                  INFIT         OUTFIT   |
|            TOTAL       COUNT      MEASURE  REALSE     IMNSQ   ZSTD  OMNSQ   ZSTD|
| MEAN       913.3       204.4          .00     .09       .74   -5.1    .72   -5.0|
| S.D.       552.5        94.6         1.77     .04      1.24    6.9   1.16    7.0|
| REAL RMSE    .10 TRUE SD    1.77  SEPARATION 17.55  ITEM   RELIABILITY 1.00|
--------------------------------------------------------------------------------
```

Figure 3 reliability of the instrument

The wright map is reasonable (see figure 4). It shows that all the students can be concluded in those items, many items are too difficult. That's interesting but it is in line with expectations. Because when students study optional curriculum, influenced by the examination, they may not have deeply understanding in structure of matter. Also it shows that some items may needs revision, such as Q64.

4 Results

1. Results show that the percentage of level in each grade like this:

In grade 9, most students are located in level 1\2\3, in grade 10, most students are located in level 3\4\5, and in grade 11, most students are located in level 4/6/7. Level 4 is the most frequent level that students located, which means octet rule may influence students' cognition most.

2. Level 5 is a little bit weak for all students. They don't used to see Electrostatic attraction when explain. Students used to use concepts and rules without seeing inside in it.

3. Most students in grade 11 can use concept of orbital, while in an localized way.

The idea of quantum theory, such as probability, wave function, and energy quantization, didn't come into students' mind when solving problems. If the structure of matter is too particle, students can hardly understanding its wave nature.

```
          PERSON - MAP - ITEM
              <more>|<rare>
 3                  +  Q82
                    |  Q24   Q79   Q80   Q81
 2                  +  Q22   Q39   Q75
                    |S Q1    Q10   Q2    Q4    Q76
 1                  +  Q11   Q15   Q21   Q26   Q3    Q32   Q36   Q45
                       Q47   Q48   Q49   Q51   Q53   Q54   Q78
                    |  Q16   Q18   Q23   Q25   Q29   Q31   Q33   Q35
                       Q37   Q38   Q40   Q43   Q5    Q52
 0              .# T+M Q12   Q13   Q14   Q17   Q19   Q27   Q30   Q34
                       Q41   Q44   Q46   Q50   Q6    Q74   Q77   Q8
           .##### S|  Q20   Q28   Q42   Q62   Q65   Q7    Q73
-1 .############  +  Q70   Q9
           .##### M|S Q68   Q71   Q72
-2   .########## S+  Q61   Q63
            .####  |  Q67
-3               . T+  Q55   Q56   Q58   Q59   Q60   Q66   Q69
                    |T
-4                  +
                    |  Q57
-5                  +
                    |
-6                  +
                    |
-7                  +
                    |
-8                  +  Q64
```

Figure 4 The wright map

References

1. Adadan, E., Trundle, K.C., & Irving, K.E. (2010). Exploring grade 11 students' conceptual pathways of the particulate nature of matter in the context of multi-representational instruction. *Journal of Research in Science Teaching*, 47(8),1004-1035.

2. Duncan, R.G., Rogat, A.D., & Yarden, A. (2009). A learning progression for deepening students' understandings of modern genetics across the 5th-10th grades. *Journal of Research in Science Teaching*, 46(6), 655-674.

3. Liu, X., & Lesniak, K. (2006). Progression in children's' understanding of the matter concept from elementary to high school. *Journal of Research in Science Teaching*, 43(3), 320-347.

4. Merrit, J.D., Krajcik, J., & Shwartz, Y. (2008). Development of a learning progression for the Particle model of matter. Proceeding of the 8th International Conference for the learning Science, Volume 2(pp.75-81).Utrecht, The Netherlands: International Society of the learning Sciences.

5. National Research Council (2012). Framework for K-12 science education: Practices, cross-cutting concepts, and core ideas. H. Quinn, H. Schweingruber, and T. Keller (Eds.), Washington, DC: National Academies Press.

6. Park, E.J., Light, G., Swarat, S., & Denise, D. (2009). Understanding learning progression in student conceptualization of atomic structure by variation theory for learning. Learning Progression in Science Conference, Iowa City, IA.

7.Smith，Wiser, Anderson, & Kracjik, J. (2006). An implication of research on children's learning for standards and assessment: A proposed learning progression for matter and atomic molecular theory. Measurement: Interdisciplinary Research and Perspectives,4(1&2),1-98

8. Stevens, S.Y., Delgado, C., & Krajcik, J. (2010). Developing a hypothetical multi-dimensional learning progression for the nature of matter. *Journal of Research in Science Teaching*, 47(6), 687-715.

9. Wilson, M. (2009). Measuring progressions: Assessment structures underlying a learning progression. *Journal of Research in Science Teaching*, 46(6), 716-730.

Research on the Learning Progressions of Organic Compounds in Secondary School

Yao Zhi (Beijing Normal University)

Email: zhi.yao@263.net

1 Background

Why do we research the learning Progressions? First, learning progressions enrich researches related to students' conceptual development and domain-specific knowledge learning. Second, learning progressions help to improve and align standards and instruction.

Why do we choose organic compounds? Organic chemistry is an important domain in chemistry and fully reflects the creativity of chemistry, and it is a complex area. Many students feel difficult when they learn. They said the structure\characteristics\reactions of organic compounds are varied and complex. Furthermore, the organization and selection of curriculum content are controversial.

So we want to know how a student cognizes organic compounds and how to describe the students learning progressions of this topic.

2 Objective

This research aims at constructing the learning progressions of organic compounds and discussing about the curriculum content and teaching. Therefore, we need to construct the model of organic compounds' cognitive mode and establish learning progressions of the organic compounds in secondary school.

3 Methodology

This research is divided into three parts. The first step is to construct cognitive mode of organic compounds. The second step is to test and revise the model. The third is to examine the learning progressions of organic compounds in senior secondary school. They are shown in Figure 1.

The research methodology is content analysis, factor analysis and and Rasch model analysis.

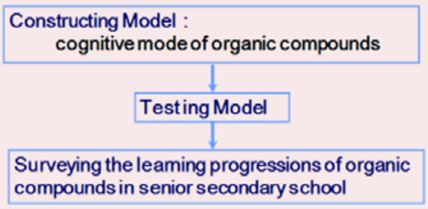


Figure 1 Research Procedure

4 Results

4.1 Constructing Model of Organic compounds' Cognitive Mode

The general theory of cognitive mode and its development is the theoretical framework of this research. The cognitive mode is the mode of cognition and reasoning using by student analyzing phenomena, solving problems and understanding ideas of specified domain. Such cognitive mode can be illustrated by the following cognitive variables: perspective of cognition, path of reasoning (relation of perspective) and cognitive pattern. So the learning progression of specific domain or topic can be described by the development of domain-specific cognitive mode of student. The development of domain-specific cognitive mode of student can described by the change of cognitive perspectives\ relations or path of cognitive perspective\ category of cognitive pattern\ level of cognition performance. The development of domain-specific cognitive mode of student is decided mostly by the transformation from knowledge to cognitive mode. As shown in Figure 2.

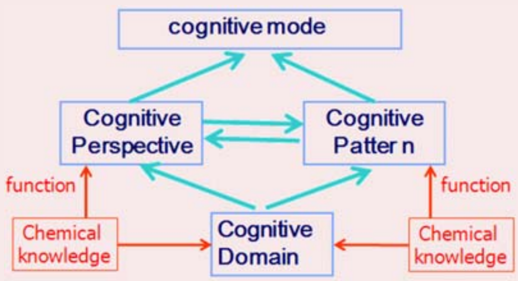


Figure 2 The model of Cognitive Mode

Based on the general theory of cognitive mode and its development, the organic compounds' cognitive mode is described by cognitive perspective and cognitive pattern, and the learning progressions of organic compounds are described by the enrichment of cognitive perspective and the conversion of cognitive pattern. For example, Figure 3 is the answer of 2 students about the question "What do you think about ethylene?" Comparing with their answers, the difference can be found. Student 2 had more cognitive perspective than student 1, such as "synthesis" and higher cognitive pattern, such as micro\system.

By analyzing the contents of textbooks of different grades, the cognitive perspectives and cognitive pattern can be identified. For example, the characteristics of ethanol are described in both grade 10 and 11 textbooks. So we identify that characteristic is the one of the cognitive perspectives of organic compounds. But we also find the difference. In grade 10, the characteristics are discussed by experiment. But in grade 11, they are discussed by functional groups or chemical bond. So, the substance, functional groups, chemical bond are the cognitive perspectives below the characteristic. And each perspective corresponds to specific cognitive pattern. Such as, chemical bond corresponds to microscopic. In this way, the cognitive perspectives, cognitive pattern and their relationship are identified. The model of organic compound's cognitive mode is shown in Figure 4.

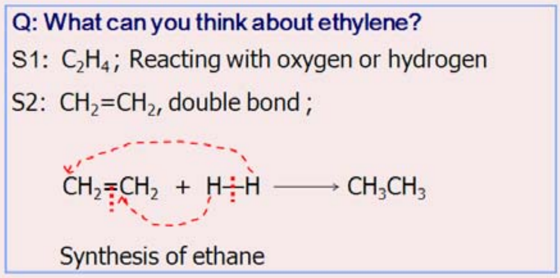


Figure 3 Two examples of the students' cognition performance

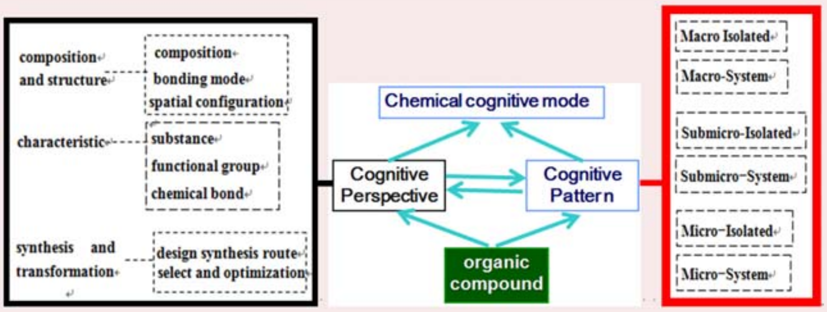


Figure 4 The model of Organic Compound's Cognitive Mode

4.2 Testing and revising model

Factor analysis approach is used to test the model. Samples were taken from 9 schools of three different academic levels. 30-40 students from two grades were chosen as samples in each school. A total of 675 students participated in the test. Based on the model of organic compounds' cognitive mode, questionnaire is developed. The result of statistical analysis (Table 1) shows that the index system is suitable for factor analysis.

Table 1 The results of statistical analysis

KMO		0.849
Bartlett Test of Sphericity	χ	1596.532
	df	253
	Sig.	0.000

Table 2 The Cognitive Perspective and Cognitive Pattern of Organic Compound

	Cognitive perspective	Cognitive pattern
1	Composition and structure (element) Composition and structure(FG) Characteristic (Functional group)	Macro-Isolated Submicro -Isolated Submicro –System
2	Composition and structure (bonding mode)	Micro-Isolated
3	Characteristic (chemical bond)	Micro-System
4	Synthesis and transformation	System
5	Characteristic (substance) Synthesis and transformation	Macro-Isolated Macro-System

From scree plot (Figure 5), 5 components were found.

From Component Transformation Matrix, the items belonging to the each component can be found. Then, the cognitive mode reflected by items can be identified. The cognitive perspective and cognitive pattern are shown in table 2. Comparing with the theoretical model, 3 perspectives were deleted.

4.3 Surveying learning *progressions by organic compounds' cognitive mode*

In the questionnaire, items are the subjective self-report questions, such as "what do you think about organic compounds?"

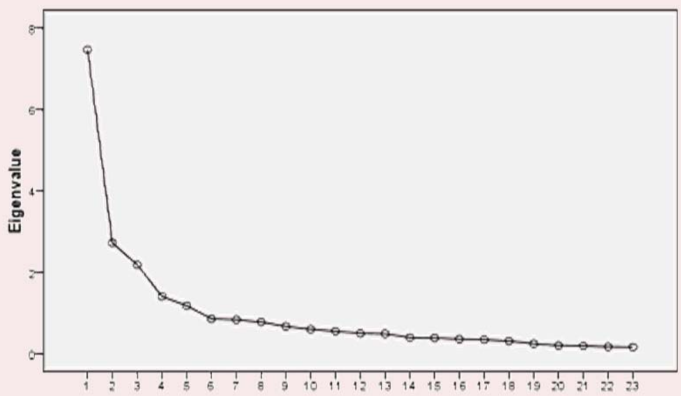


Figure 5 Scree plot

Based on Rasch model and the organic compounds' cognitive mode, 21 codes are identified. 675 students from 9 schools are chosen as samples.

Data was analyzed in 2 ways. The Rasch model is used to test for statistical analysis, identifying the levels of learning progressions of senior secondary school students. The difference test is used to identify the development of cognitive mode of different grade students. According to the wright map from Rasch analysis, 5 levels (Figure 6) were identified. Each level was described by cognitive perspective and cognitive pattern.

According to the distribution of students that is shown in figure 7, 4 levles can be found, which were consistent with the results from Rasch model.

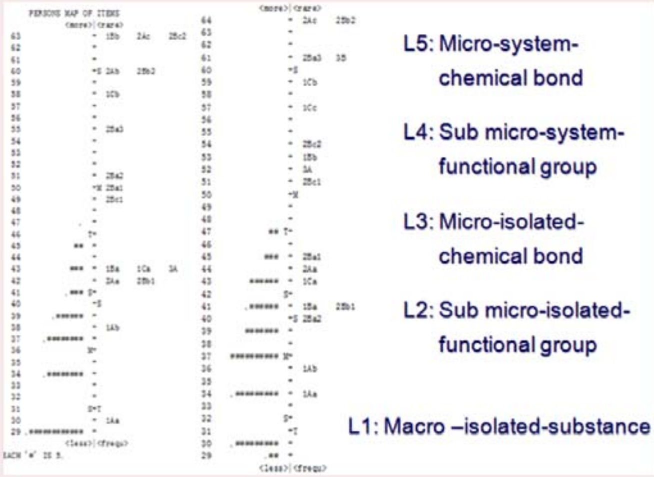


Figure 6 Wright map and the development level of LPs' organic compounds

According to the difference test, There is a significant difference on cognitive perspectives and cognitive pattern between the grade 10 and 11, which are composition-submicro-system, bonding-micro-isolated,FG-submicro-system , synthesis-submicro-system (figure 8).

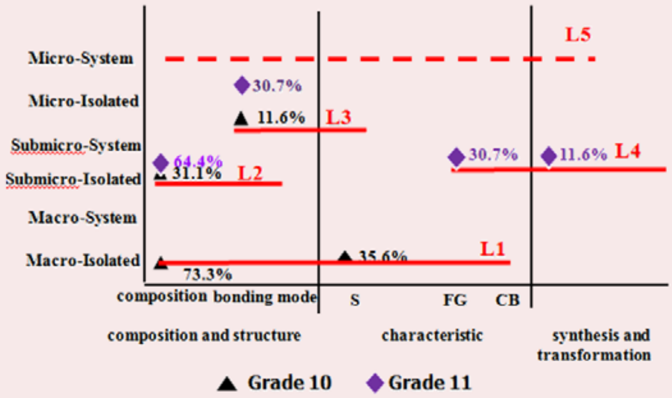


Figure 7 The distribution of students

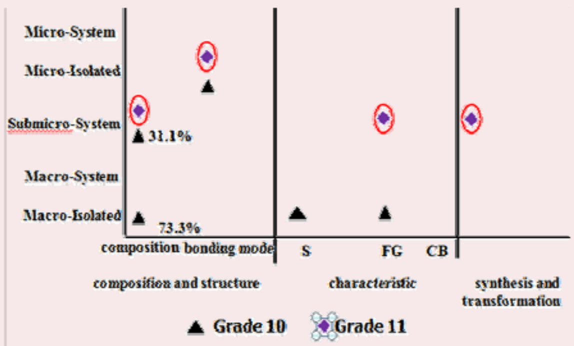


Figure 8 The significant difference on cognitive perspectives and cognitive pattern between grade 10 and

5 Conclusions

Based on the result, we can get the following conclusions:

- The learning progressions of organic compounds are divided into 5 levels:

  L1: Macro –isolated-substance

  L2: Submicro-isolated-functional group

  L3: Micro-isolated-chemical bond

  L4: Submicro-system-functional group

  L5: Micro-system-chemical bond
- In the learning progressions of organic compounds, the key cognitive perspectives are "functional group" and "chemical bond", the key cognitive pattern is "system".
- According to the learning progressions, the learning of students are divided into 3 stages: based on substance, based on functional groups and based on chemical bond.
- In grade 10, based on substance may be suitable.
- In grade 11, based on chemical bond maybe suitable for a few students.

You are welcome to distribute this newsletter to your colleagues and students. But do not use portraits and logos without permission.

Assessment on Junior Secondary School Students' Learning Progression of Chemical Change

Li-na ZHANG (*College of Chemistry, Beijing Normal University, No. 19 Xinjiekouwai Street, Beijing, China 100875*)
E-mail: zln000407@163.com

1 Introduction

Over the past decade, there has been increased interest in learning progression (Smith C, Wiser M, Anderson C W, et al, 2004; Smith C, Marianne Wiser, Charles W. Anderson，Joseph Krajcik, 2006; Salinas I.2009; NRC, 2012). Recent studies focused on curriculum design (NRC,2012), instruction and assessment (XiuFeng Liu, Kathleen M. Lesniak, 2005, 2006; Claesgens, Scalise, Wilson, & Stacy, 2009; Philip Johnson and Peter Tymms, 2011). Four building block model (Wilson 2005, 2009) and construct-centered design (CDD) process (Krajcik, Shin, tevens & Short, 2009; Pellegrino, Krajcik, Stevens, et al., 2008) has been followed to build learning progression (Shawn Y. Stevens, Cesar Delgado, Joseph Krajcik, 2010). Rasch model has been used more and more to dived different learning progressions (XiuFeng Liu, 2010; ZuHao Wang, et al, 2010, 2012) in specific domain. Students' heavy academic burden in junior secondary school has been a real problem of Chinese education; it has also been mentioned to solve in the next 10 years (Ministry of Education of the People's Republic of China, 2010). Through decades of implementation of chemistry curriculum, we have seen far from meeting the demand of the problem-solving, because there are too many details to be memorized. Therefore, it is necessary to assess students' progressive and deep-rooted understanding of big ideas, such as chemical change. Students' deep understanding of big ideas related with their cognitive mode in Chemistry (Wang Lei et al., 2005-2012). However, large-scale examination, as well as homework , to assess the students' sustained, deep-rooted understanding is weak.

For the development of students' progressive and deep understanding of chemistry big idea, the study aims to evaluate students' progressions of chemical change. It is important to know:

(1) What is the junior secondary students' learning progression of chemical change?

(2) Which factors may influence students' learning progression?

2 Theoretical Framework

Over the years we can observe students' external performance in the classroom. Students learn the same knowledge may behave differently: some students can only remember, while others can explain, still others can design experiments. For many years we wondered which cognitive factors will affect students' performance in chemistry learning. It likes a 'black box'. Piaget use schema to describe the cognitive structure and cognitive development. Rumhart emphasized more on knowledge which promote cognitive development. Additionally, he promoted there were variables inside the schemes. Zhong-liang Feng made it clear that the most important thing of instruction would be constructing psychological structure, which determines students' external performance. Cognitive structure is an important part of the psychological structure.

What will happen to the student's cognitive structure when chemistry instruction started? And how does it progress? There is interior factor which influences specific concept learning and student's cognition about specific topic and content domain. The factor is a kind of thinking model which is used in conceptual understanding and problem solving. That is cognitive mode. The cognitive mode is the mode of cognition and is used when analyzing phenomena, solving problems and understanding ideas of specific domain. There are three components of cognitive mode: (cognitive mode can be illustrated by knowledge variable and cognitive variables): (1) knowledge; (2) cognitive perspective, and (3) cognitive pattern. This mode is domain specified, and it will decide what kind of cognitive task the student will deal with and their performance level. It is reflected by the performance (Lei Wang et al., 2002-2013).

3 Method

Rasch model is widely used to develop learning progressions. It is an item response theory (IRT), which tries to get an objective and equally spaced scale through testing students' response. Recently, Rasch model has been used more and more in psychology and pedagogy for it can overcome the CTT's (Classical Test Theory) disadvantages of tool-dependent and sample-dependent. Previous studies developed 'four building blocks' to test students' learning progressions, which include construct maps, the items design, the outcome space, and evidence of high-quality assessment (Wilson, 2005, 2009). While science educators proposed construct-centered design (CDD) process (Crajcik, Shin, Stevens & Shor, 2009; Pellegrino ,Krajcik, Stevens, et al., 2008), and computer model based-assessment (Liu, 2010) process.

Based on the literatures, we followed the steps:

(1) Building the model of specific domain cognitive mode by interview, content analysis and mental simulation for cognitive activity;

(2) Unpacking and constructing the framework;

(3) Constructing LPs assessment;

(4) Developing instrument based on Rasch model;

(5) Survey and revising the cognitive mode and instrument;

(6) Identifying the level of learning progressions-building the level model;

(7) Using the level model to find the difference among students; and

(8) Using the level model to trace students' progression.

The process can be divided into 2 parts. First, researchers developed a cognitive model which aims at revealing mechanism influencing the learning of chemical change. Researchers unpacked the core idea, extracted the key elements, by analyzing subject matter knowledge, test paper and literature about learning, and then constructed the cognitive mode which serves as a Hypothetical Learning Progression. Second, by data collection and students' performance analysis, researchers built development level model. This step include review on misconceptions and student interviews; then design items, administer pilot test and build the scaling rule according to students' performance. Questionnaire was followed to get the evidence of students' performance. Data analysis is based on Rasch model from which to revise the item and characterize the development level.

3.1 Build a Hypothetical Learning Progression (HLP)

Similar to construct-centered design (CDD) process, we unpacked the big idea –chemical change into smaller construct in a concept map based on inspection of chemistry syllabus. As a reliability check, in order to ensure all the knowledge referred to the same topic area, seven concept maps were developed. The entire concept maps were validated by a college expert who were involved in teaching chemistry, 1 junior secondary school chemistry teacher, 1 college expert who major in chemistry education. Tasks, such as recognizing, predicting, were chosen based on Bloom's taxonomy of Educational Objectives (Revised), and informed by the analysis of the large scale assessment, such as PISA, TIMSS, NAEP, and the inspection of the national standards documents (MEPRC, 2011). After inspection of experts, we developed the HLPs of students' performance.

Cognitive perspectives and cognitive pattern were extracted according to the analysis of chemistry syllabus in and abroad, university chemistry textbook, junior secondary school chemistry textbook and experts' interview. As a result, 2 perspectives to understand chemical change were detected, (1) matter and energy, and (2) quantity, transformation and application. Each perspective can be unpacked into several sub-perspectives, such as to understand form the perspectives of (1) types of substances involved in the reaction; e.g., classify familiar chemical change; (2) types of particles involved in the reaction; (3) types of elements involved in the reaction; (4) types of energy involved in the reaction. E.g., recognize some chemical reactions release energy (e.g. heat, light) while others absorb it. There are four cognitive patterns: (1) macro-micro; (2) qualitative-quantitative; (3) fragmented-systematic; (4) static-dynamic. All the cognitive variables (perspectives and patterns) were validated by experts. We studies how do knowledge variable and cognitive variables affecting students' performance in learning chemical change and its progression. The data were analyzed with SPSS software.

3.2 Developing Empirical progressions (EP)

Instrument There are three parts of the instrument:

● Paper and pencil test, including 3 types of item.

(1) Concept map. Knowledge portrayed the students' memorizing and relating levels of chemical change. The big idea "Chemical change" should be unpacked into small constructs. Concept map would be used to examine students' knowledge construction of chemical change.

(2) Five-point Likert scale. Perspectives is cognitive variable portrayed the students progression levels of chemical change. Perspectives were designed into a five-point Likert scale, as part of the student paper and pencil test. Students were required to reflect on whether there were certain perspectives from the view of self-reflection. However, there is a problem that students can recognize from a certain perspective, does not mean he/she can solve the problem really from this point of view. There may be deviation. The bias should be solved by students' interview and think-aloud tasks.

(3) Multiple-choice items and constructed- response items. Multiple-choice items and constructed- response items were designed to examine whether the students were able to accomplish certain understanding tasks.

● Students interview and think-aloud tasks. As the students' age and the problem that a student may say he/she can solve a problem from a certain perspective, but cannot really do that. It is necessary to verify repeatedly in students interview and think-aloud tasks.

Participants About 300 students from 3 junior secondary schools were involved in this research. 46 teachers participated in the interview belonged to 3 distinct populations.

Data analysis The data were analyzed by the score. Six chemistry educators finished the work of scoring. Scorer reliability was calculated by SPSS program. And the program was used to calculate the construct validity, and some other analysis, to know the influent factor of students understanding progression level in chemical change.

Rasch model were used to (1) review if certain items were necessary to add or to delete; (2) divide different progression levels.

4 Result and Discussion

There are different progressions in chemical change which are not quite consistent with the expected ones. Result shows that:

1. Students' performance can be divided into 3 learning progressions form 'knowing', 'applying' to 'problem solving'. Knowing is the first progression level. It is easier for students to memorize familiar chemical change and to write down chemical equations; classify the type of chemical reactions. To compare or explain is more difficult. It is hard for students to design experiment procedures, or select and effectively combine experiment apparatus, or prove/argument/ find solutions/draw conclusions. Reflecting/evaluating effectively on experiment design is the most difficult task for students to finish. And, there is significant difference among students from different schools.

2. Different students' performance embodied their different understanding of chemical change. Students' performance was determined by their chemistry cognitive mode. Among knowledge, cognitive perspective and cognitive patterns, perspective is the most important element which affecting students learning on chemical change.

3. Students cognitive development progressed in the 1-year junior secondary chemistry instruction. But, some tasks, perspectives are expected to be improved. Instruction, including new teaching and recitation, can promote student's learning progression significantly. Additionally, students' ability on predicting and concluding after recitation are better than that of in the newly teaching period. Some abilities progression is weak, for example, describing the phenomena of experiment. Reflection and evaluation, summarizing and putting forward new questions are expected to be improved.

Study on Middle School Students' Learning Progression of Electrolyte Solution: Under the Perspective of Chemical Cognitive Mode

Boyuan Yin (Institute of Chemical Education,
College of Chemistry, Beijing Normal University,100875)

Abstract: Electrolyte solution is an important and complex system in chemistry. In this study we describe students understanding of the electrolyte solution in the perspective of Cognitive Mode. There are 362 students participated in this study and Rasch Model for data analysis. As a result, five levels can be derived from students' performance.

Key words: Electrolyte Solution, Learning progression, Cognitive Mode, RASCH model

1 Significance

The electrolyte solution is an important system in chemistry, since a large number of common chemical reactions are carried out in solution phase. Learning the behaviors of the substances in solution will enhance high school students' understanding of chemistry. The electrolyte solution is one of the core area with which high school students can develop their chemical understandings. It requires students' systematic thinking, and flexible reasoning. Hence, the electrolyte solution has been a core content of the high school chemistry syllabus. It's also difficult for them to understand.

2 Method

Either from the aspect of disciplinary value or learning psychology, research on students' understanding towards the electrolyte solution is of great importance. Both domestic and foreign researchers looked into students' understanding towards the electrolyte solution from the aspect of "alternative conceptions". However, the reason why those alternative conceptions appear is not fully explained. Mei-Hung Chiu *et. al*. employed the "Mental Model" to classify and explain students' misconnects, and by studying the "alternative conceptions" change or development among different-stage students with this "mental model". Although they have made some evolutionary progress, they didn't explain why students have such "mental model". At the same time, there are a lot to learn from some foreign researches on "learning progression". However, the majority of those studies pay more attention to interdisciplinary "big idea", few were focused on the specific contents, such as the electrolyte solution. During the study of "Matter" conception, Krajcik *et. al*. developed the "Learning Progression Model", which clearly depicted students' learning progression in the dimensions of periodic table, atomic structure, and electrostatic force. Meanwhile, no interactions among those three dimensions were discussed.

In this study，a model of Cognitive Mode is built firstly, in order to show the systemic understanding of electrolyte solution (base on the previous studies), as displayed in Figure 1.

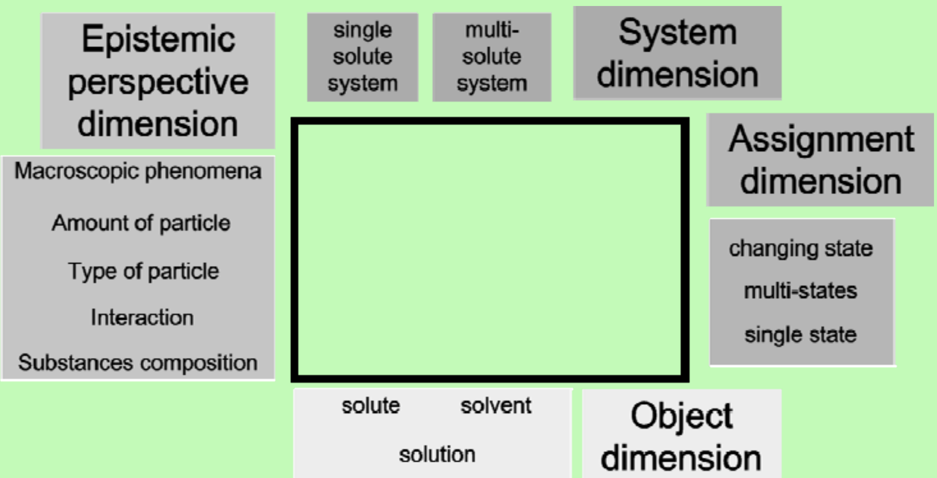


Figure 1 The model of Cognitive Mode of Electrolyte-solution

This model summarizes various electrolyte systems and corresponding questions which high school students might face with. It can be considered as the ideal state of high school students' understanding. The left panel of this model list five Cognitive Perspectives which need to be used actively when solving related problems. This study anticipates that students' overall learning progression on electrolyte solution is raised as the increase of those cognitive perspectives, the deepening of the perspective connotation, and the richness of the relationship between those perspectives.

To test the reasonableness of the electrolyte solution learning model in Figure 1, questionnaire is designed to elicit students' performance on different Cognitive Perspectives (including macroscopic phenomena, substances composition, interaction, particle types and amounts). Questionnaire is administered to students from different grades and different classroom in three high schools in Beijing, with results shown in Table 1.

Table 1 Students' performance on the five Cognitive Perspectives

Cognitive Perspectives	What can students do base on the questionnaires	Level of students' performance
Substances composition	Cannot distinguish strong electrolyte and weak electrolyte	Lv1
	Understand strong electrolyte and weak electrolyte, and the nature of acid salt	Lv2
Amount of particle	Focus on a single ion concentration only	Lv1
	Consider other ion concentration in an equilibrium	Lv2
Interaction (equilibrium)	Consider complete ionization only	Lv1
	Consider the ionization equilibrium of solute, ignore the solvent's	Lv2
	Consider equilibrium of both solute and solvent, ignore the interaction between them	Lv3
	Consider the interaction between equilibriums	Lv4
Type of particle	Cannot realize particle in the electrolyte solution	Lv1
	Focus on molecules in the solution only	Lv2
	Consider ions from solute only	Lv3
	Consider ions from both solute and solvent	Lv4
Macroscopic phenomena	Associate solute only	Lv1
	Associate equilibrium and ion concentration	Lv2

The result shows that, in each Cognitive Perspective, students' performances display a manifest hierarchy. It's interesting to consider all of the five perspectives together. A further test was carried out in different class, ranges from grade 9 to grade 12, four high schools in Beijing. A total of 362 questionnaires were administered, and 340 were valid. Data analysis with Bond & Step Software shows item reliability of 0.99, and person reliability of 0.84, which proved the reliability of the questionnaire. The Wright Diagram is displayed in Figure 2 (on the next page).

3 The characteristics of student's understanding of electrolyte solution

Wright Diagram shows significant differences between students' performance, which could be used to distinguish levels of understanding.

Students in level 1 do not consider interactions between solute and solvent. They think that acetic acid is only composed of acetic acid and water molecules.

Students in level 2 focus on complete ionization, they focus on fully ionized, thus think acetic acid as sodium chloride as a fully ionized, produce hydrogen ions and acetate.

In level 3, students notice equilibrium while they consider the interactions between equilibriums.

In the highest level (level 4), students know the primary and secondary of equilibriums. As shown in Figure 3.

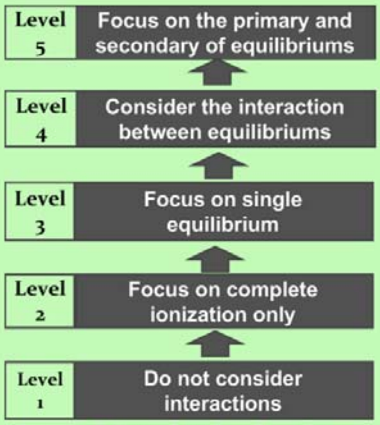


Figure 3 Four levels of students' understanding of electrolyte solution

This study also found that the overall students' level is related to their grades and their gained knowledge as well. Generally, the higher grade students are at a higher level. However, the grade is not a determining factor to understandings level. As Figure 4 indicates, a 10th grade student can reach the fourth level, while a 12th grade student may stay at the level stage.

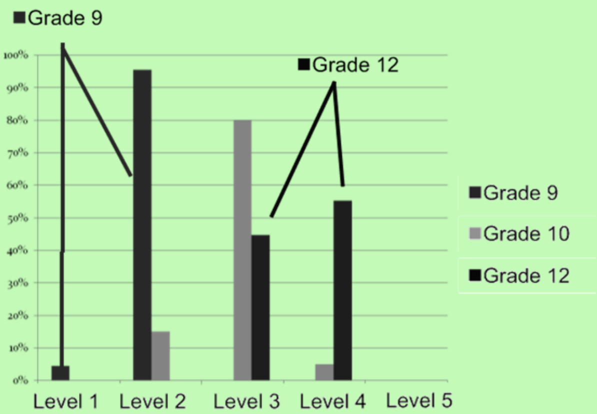


Figure 4 Students in three different grades and their understanding levels

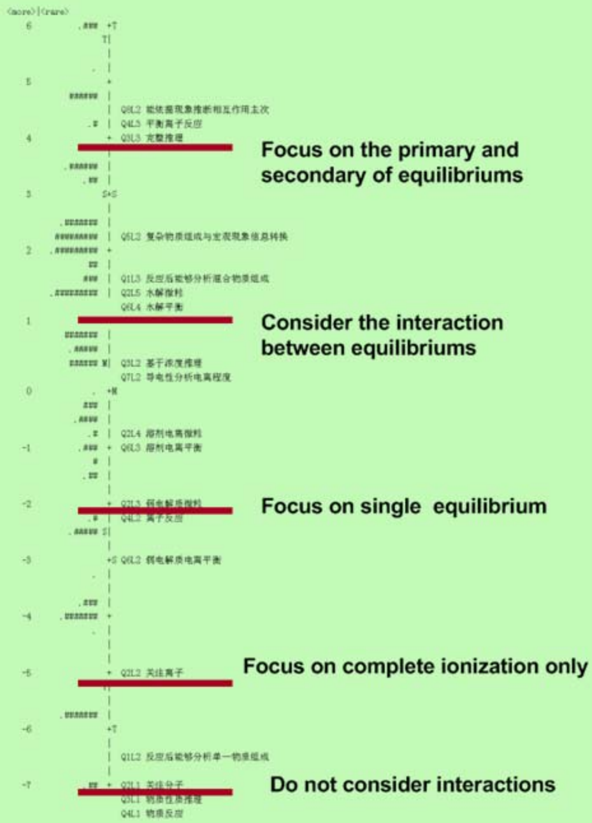


Figure 2 Wright Diagram of students' performance

4 Implications

To propose learning progression of students' electrolyte-solution-understanding is helpful for both curriculum design and teaching practice. Based on the level from the model, teachers can design the teaching tasks for different grades as a whole. This makes teaching more targeted, and reduces repetitive work. For a certain grade, this model provides a reference to students' current stage and the anticipated teaching goals, which help teachers to understand students' zone of proximal development.

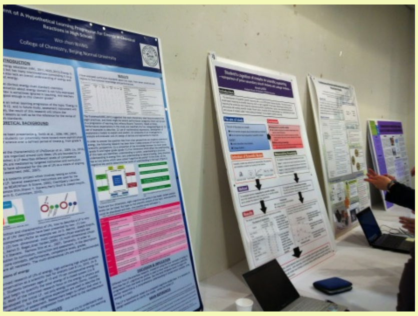
There are some limitations in this study. More test items should be added when developing the tests tools. And to improve the validity of this tool, the amount of test samples should be also enlarged.

EASE Winter School in Seoul: An unforgettable Experience

Weizhen-Wang (Beijing Normal University)

2014 EASE Winter school has been closed for about two months, but the scenes still leap before my eyes. The experience gives me a worthy and improving pleasure.

The preparation for the poster presentation was a previous opportunity to take a new look at my research. It was not an easy thing for me to refine a long paper into some big themes or key messages in a poster. I organized thoughts and chose modes of presentation which would punch the idea into one's processor almost immediately. In the process of poster presentation, lots of new words, interesting thoughts and valuable suggestions impacted me, and I was so excited that I wrote the ideas down and shared my opinions with my new friends.



Lectures provide another good chance to expand my academic vision. Winter school arranged several lectures for us which were all about the hottest research fields, like SSI, learning progressions, scientific argumentation and so on. The professors are so kind and patient that they introduced their research by vivid methods, interesting examples and answered our questions. The lecture of SSI education raised by Professor Lee impressed me deeply. In China Mainland, I didn't know much about this topic before, for SSI is not as popular as it in Korea. But through the lecture, I noticed that SSI education is really considerable for improving students' scientific literacy in today's world and very interesting. Not only the hottest research subject, but how to raise good research questions and how to choose the most appropriate methods, these basic but important topic were also guided by professors.

In winter school, one of the main missions for us is working in our own groups to develop a research proposal. It was a tight schedule but we did it, hard work but happy. In my group, we had a coach, Kongju and 5 members from 4 regions. It was difficult to figure out a common topic because we all have different research fields. Reading papers, discussion, argumentation, tidying thoughts, and that cycle repeated again and again, we finally focused on SSI teaching and intended to combine it with motivational design. The following work was also full of challenges. Refining theoretical background, ensuring research questions and research design, raising theoretical model, we stayed up late every night and eventually finished it. I was filled with pride, happiness and gratefulness at the moment we finished our group presentation. Happiness was from a sense of fulfillment. It was our hard work that produces our achievement. And we were pride for finishing our work flawlessly, for the perfect work means a strong capacity and an effective teamwork. I was also grateful for our coach and group members, I cannot imagine the proposal could be done in such a short time.

Friendship is another harvest for me in this winter school. Making new friends and sharing interests with others are always exciting parts of social life. We are used to make native friend in school, but with little chance to get acquainted with foreign friends, especially get to know many foreign friends all at once. In this nice January, I came to know Lei Gao who came from China but has been studying in Korea. She showed us around the Seoul city; I knew my dear roommate Jennifer, we had a very happy week in one room; I got my energetic group members who are full of passion and creativity, we finished our group proposal together and the debating and discussion benefited me a lot; I was lucky to meet an excellent and generous coach Kongju, with whose help, everything in winter school went smoothly. Although English is not our native language, it never became obstacle. We knew each other very well by smile, gesture, body language,

and even google. As the saying goes, sincere hearts are connected with each other.



Ewha Womans University is a very beautiful place. Although it was winter when I was there, I enjoyed the quiet campus and I could imagine the wonderful scenery in spring. Seoul is a lovely city, it is similar to Beijing, and I really like it. I would like to thank EASE, APCTP and all the staffs for their thoughtful arrangements for winter school. The food and lodging was very good and the culture visit was also fantastic. Even when we stayed up for discussion, it was very warm that the midnight snack was always ready for us.


I treasured the experience of winter school, for it gave me a lot, a wider research field of vision, many practical suggestions, and many friends. Winter school was filled with passion, happiness and enthusiasm, and I hope to have another opportunity to attend it again.

RISE SCIENCE EDUCATION SPECIAL ISSUE

Research in Science Education invites papers for a special issue on **Futures in Science Education.**

An Expression of Interest (EoI) is due **JUNE 13th 2014**, with full paper submissions required by **NOVEMBER 2014** for publication in **Late 2015** or **early 2016**.

Interested researchers should email one of the two guest editors with any inquiries:

Associate Professor Debra Panizzon
Faculty of Education, Monash University
debra.panizzon@monash.edu

Professor Peter Aubusson
School of Education, University of technology Sydney
peter.aubusson@uts.edu.au

Articles for the special issue should explore **Futures in Science Education** with many different ways of tackling futures possible. For example, articles may:

- Contrast probable futures, based on trends, with a desirable future grounded in research-based knowledge;

- Outline a futures agenda for research that will impact on and influence the future directions of science education;
- Exploit futures tools and methods to explore 'possible', 'probable' or 'potential' futures;
- Explore the socio-political environment and its implications for science education futures in a particular or contrasting contexts; and
- Focus on futures in specific fields of science education, such as teacher education, technology, science education assessment, science curriculum, or pedagogy.

The term ***Futures*** is being used in the special issue to highlight the notion that there will be many different futures in many diverse places and contexts. Articles might reflect this by not predicting or proposing a single future but by considering alternative futures. Analysis of current trends and research findings to consider likely, desirable or potential futures, or to elaborate future directions for science education is encouraged.

The **Expression of Interest** should include the following:

Title of paper

Authors

Affiliations and contact details

Abstract 300 - 500 words

Once completed the EoI should be sent as an attachment to Debra Panizzon by **13th JUNE 2014.**

Notes on selection criteria

The editors are seeking futures-oriented, scholarly work with a sound research base that is of interest to a wide audience. Authors should attend to these four attributes in their abstracts.

The selection of potential articles will take into account the need for diversity in the issue as a whole. In particular, the issue aims to ensure coverage of a range of international perspectives, themes, topics and contexts.

The editors encourage collaborative authorship that might include researchers from two or more countries; an early career researcher writing with a leading science education researcher; or writing with an ASERA member. However, authorship is not limited to these.

Kind regards

Debra Panizzon and Peter Aubusson

Upcoming Conferences

1. Canada International Conference on Education. Jun. 16-19, 2014 @ Cape Breton University, Nova Scotia, Canada http://www.ciceducation.org/
2. Science Education at the Crossroads 2014. Call for Proposals in March 2014, with an anticipated meeting in September 2014. http://www.sciedxroads.org/callpaper.html
3. 11th International Conference of the Learning Sciences. June 23-27, 2014 @ Boulder, Colorado, USA http://www.isls.org/icls2014/
4. 2nd International History, Philosophy and Science Teaching Asian Regional Conference. Dec. 4-7, 2014 @ Taipei, Taiwan.
5. The Thirteenth International History, Philosophy and Science Teaching Conference will take place 22-24 July 2015 at Rio de Janiero, Brazil. http://conference.ihpst.net/

6. The Association for Science Teacher Education 2015 conference will be held 7-10 Jan 2015 in Portland, OR. Conference proposals are generally due in mid July of the preceding year. http://theaste.org/meetings/2015-international-meeting/
7. The European Science Education Research Association will hold its 2015 conference in Helsinki, Finland. http://www.sails-project.eu/portal/event/esera-european-science-education-research-association-conference-2015
8. The 2015 conference will be held February 26-28, 2015 in Grand Rapids, MI. (Submissions are generally due the preceding October.) http://www.msta-mich.org/
9. 2015 EASE Science Education Conference, Date will be announced. @ Beijing, China Mainland

Executive Members of EASE 2014-2016

President

Lei WANG, Beijing Normal University

Vice President

Yoshisuke KUMANO, Shizuoka University
Sheau-Wen LIN, National Pingtung University of Education

Secretary

Alice Siu Ling WONG, The University of Hong Kong

Treasurer

Shinho JANG, Seoul National University of Education

Executive board

Hong Kong

Alice Siu Ling WONG, The University of Hong Kong
Winnie Wing Mui SO, Hong Kong Institute of Education
Yau Yuen YEUNG, Hong Kong Institute of Education
Pun Hon NG, The Chinese University of Hong Kong

Japan

Hiroki FUJII, Okayama University
Yoshisuke KUMANO, Shizuoka University
Hisashi OTSUJI, Ibaraki University
Manabu SUMIDA, Ehime University

Korea

Shinho JANG, Seoul National University of Education
Chan-Jong KIM, Seoul National University
Youngmin KIM, Pusan National University
Sun Kyung LEE, Cheongju National University of Education

Taiwan

Sheau-Wen LIN, National Pingtung University of Education
Hsiao-Lin TUAN, National Changhua University of Education
Chia-Ju LIU, National Kaohsiung Normal University
Sung-Tao LEE, National Taichung University of Education

China Mainland

Weiping HU, Shaanxi Normal University
Jian WANG, Beijing Normal University
Yanning HUANG, Capital Normal University
Lei WANG, Beijing Normal University

Headquarters

Visit Beijing Normal University at: www.bnu.edu.cn

Executive director

☺ Rui WEI, Beijing Normal University (Jan 1, 2014 -)

Chief Editor of E-Newsletter

☺ Jian Wang, Beijing Normal University (Jan 1, 2014 -)

Editors of the EASE Newsletter

Issues to be in charge	Responsible editor	Region
Mar., 2014	Prof. Jian Wang (wangj@bnu.edu.cn)	China Mainland
Jun., 2014	Prof. Hyunju Lee (hlee25@ewha.ac.kr)	Korea
Sep., 2014	Prof. Shiho Miyake (miyake@mail.kobe-c.ac.jp)	Japan
Dec., 2014	Prof. Hsin-Yi CHANG (hsinyichang@nknucc.nknu.edu.tw)	Taiwan
Mar., 2015	Prof. So, Wing Mui Winnie (wiso@ied.edu.hk)	Hong Kong

You are welcome to distribute this newsletter to your colleagues and students. But do not use portraits and logos without permission.