

Exploring the Use of Concept Chains to Teach Scientific Concepts-Understanding of Photosynthesis

Developed at 2010 EASE Summer School
National Taiwan Normal University
Taipei, Taiwan
July 18~23, 2010

Cheng Liu, Beijing Normal University

Exploring the Use of Concept Chains to Teach Scientific Concepts

——Understanding of Photosynthesis

Name : Liu Cheng
Mentor : Prof. Liu Enshan
Domain : Biology Education

Contents

- ◇ Literature Review
- ◇ Rationale
- ◇ Research Questions
- ◇ Research Design
- ◇ Literatures

Literatures Review

Researches on concepts ontology:

- ◇ What's the concept?——mental representation (*Robert W. Howard,1987*)
- ◇ The category of concepts? ——matter, process, mental state (*Chi,1992*)
- ◇ The representation of concepts——label/words/terms, statements/proposition, meaning
- ◇ Uses of concepts

Researches about concepts learning:

- ◇ Constructivism
- ◇ Concept change model (*Posner G.J., et al, 1982*)
- ◇ Incompatibility (*Chi, 1992*)
- ◇ Meta-conceptual Awareness (*Vosniadou, 1998*) & Meta-cognition (*Flavel, 1979*)
- ◇ Dual Situated Learning Model (*Hsiao-Ching.She,2003*)

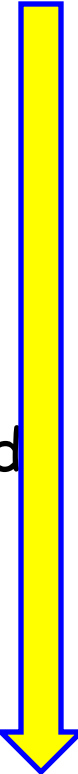
Literatures Review

Concept chains:

◇ concept-sorting strategy, key ideas, declarative sentences, stepping stones
(*Janet Machin, Janet Varleys, Peter Loxley, 2004*)

Concept Chain of Key Ideas for Light

- Light is given out by very hot objects, called sources.
- The Sun is very hot and gives out light.
- A light bulb gives out light because the filament is very hot.
- Light travels in straight lines away from a source.
- Light passes through some materials---these materials are said to be transparent.
- Some materials block (absorb) light.



Literatures Review

Concept Chain of Key Ideas for Light

- Some materials block (absorb) light.
- When materials block (absorb) light they get warmer.
- Materials which block light are called opaque.
- When objects block light they can create shadows.
- A shadow is due to the absence of light.
- Darkness is due to the absence of light.
- Shadows are formed because light travels in straight lines and does not bend around an object.

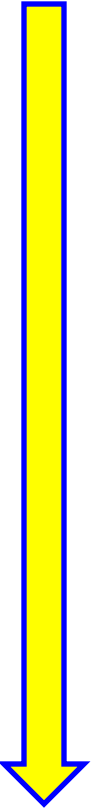
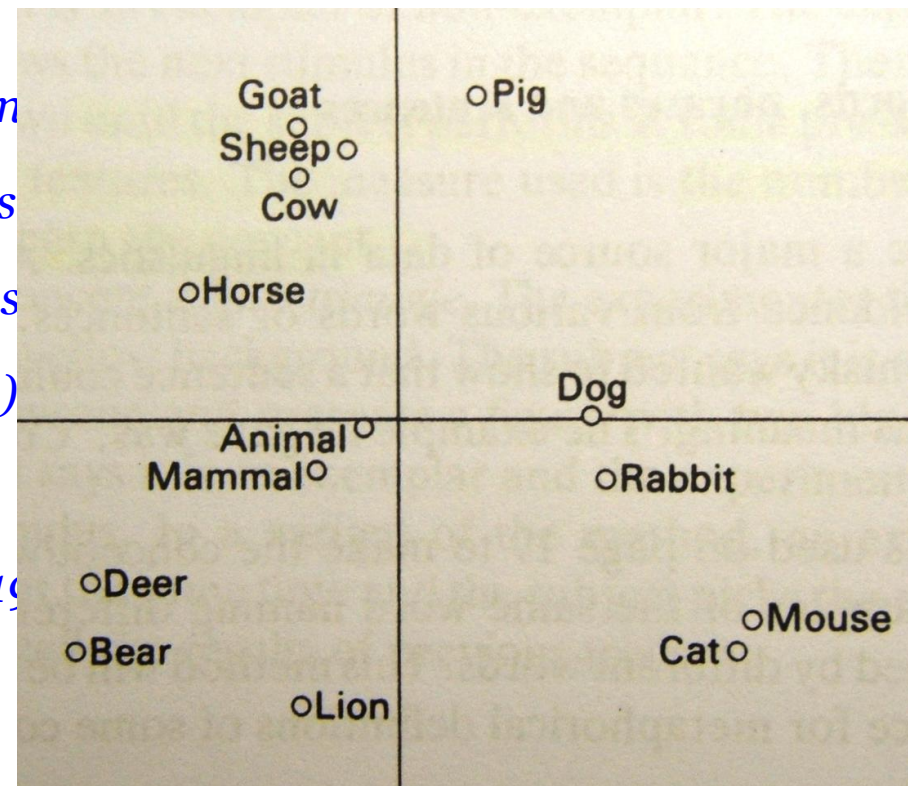


Figure. An exemplar concept chain

Literatures Review

Evaluation of students' understanding of concepts

- A. Portfolio (*Orland-Barak,2005*)
- B. Concept Mapping (*Novak & Muson*)
- C. IAI & IAE (*quote from a secondary s*)
- D. Two-Tier Diagnostic Test (*Treagus*)
- E. Graphic method (*Sacit Köse,, 2008*)
- F. Free-sort task (*Robert, 1987*)
- G. Multi-dimensional scaling (*Rips, 19*)

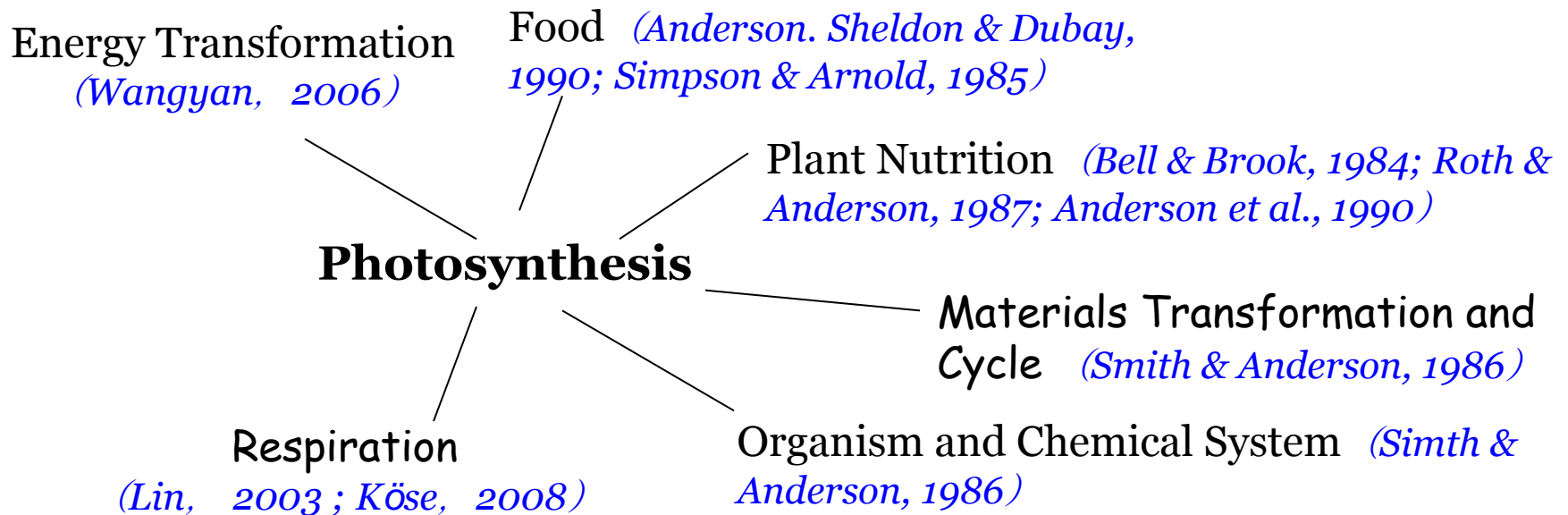


Literatures Review

Research of Concepts about“Photosynthesis”

The importance of learning concepts of “photosynthesis”.*(Eisen, Y. and Stavy, R. 1988)*

Harvard graduates were shown a seed and a log and asked where most of the mass of the log came from. The most common responses were that it came from the soil or that it came from the water.*(Harvard-Smithsonian Center for Astrophysics. 1995.)*

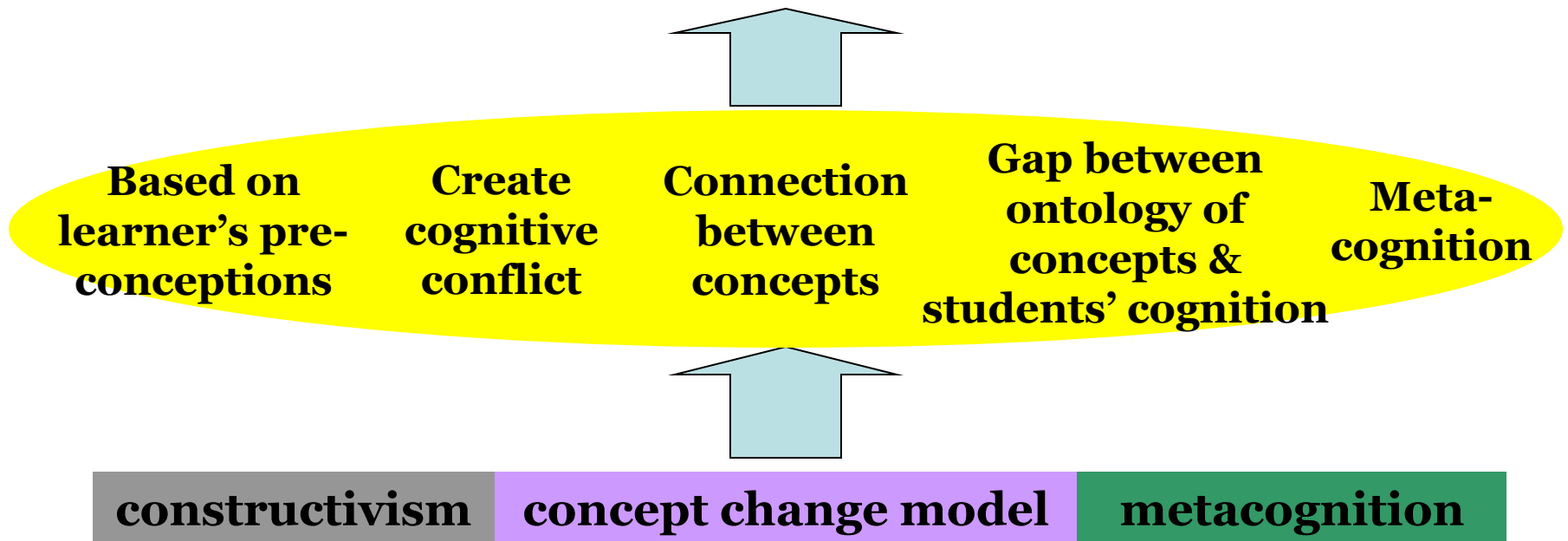


Rationale

Scientific Literacy → Less is more → The significance of related concepts about photosynthesis

“Photosynthesis”

Using concept chains to teach conceptions



Research Questions

I . What the label “photosynthesis” represents?

1. What the meaning of the label “photosynthesis” contain?
2. What's the relationship of these concepts related to photosynthesis?

II . What are students' current understandings of photosynthesis? For example, in Beijing.

1. What are students' common and different pre-conceptions of photosynthesis between china mainland and other countries/districts?
2. What should we focus on when we design teaching plan of photosynthesis based on these common and different pre-conceptions?

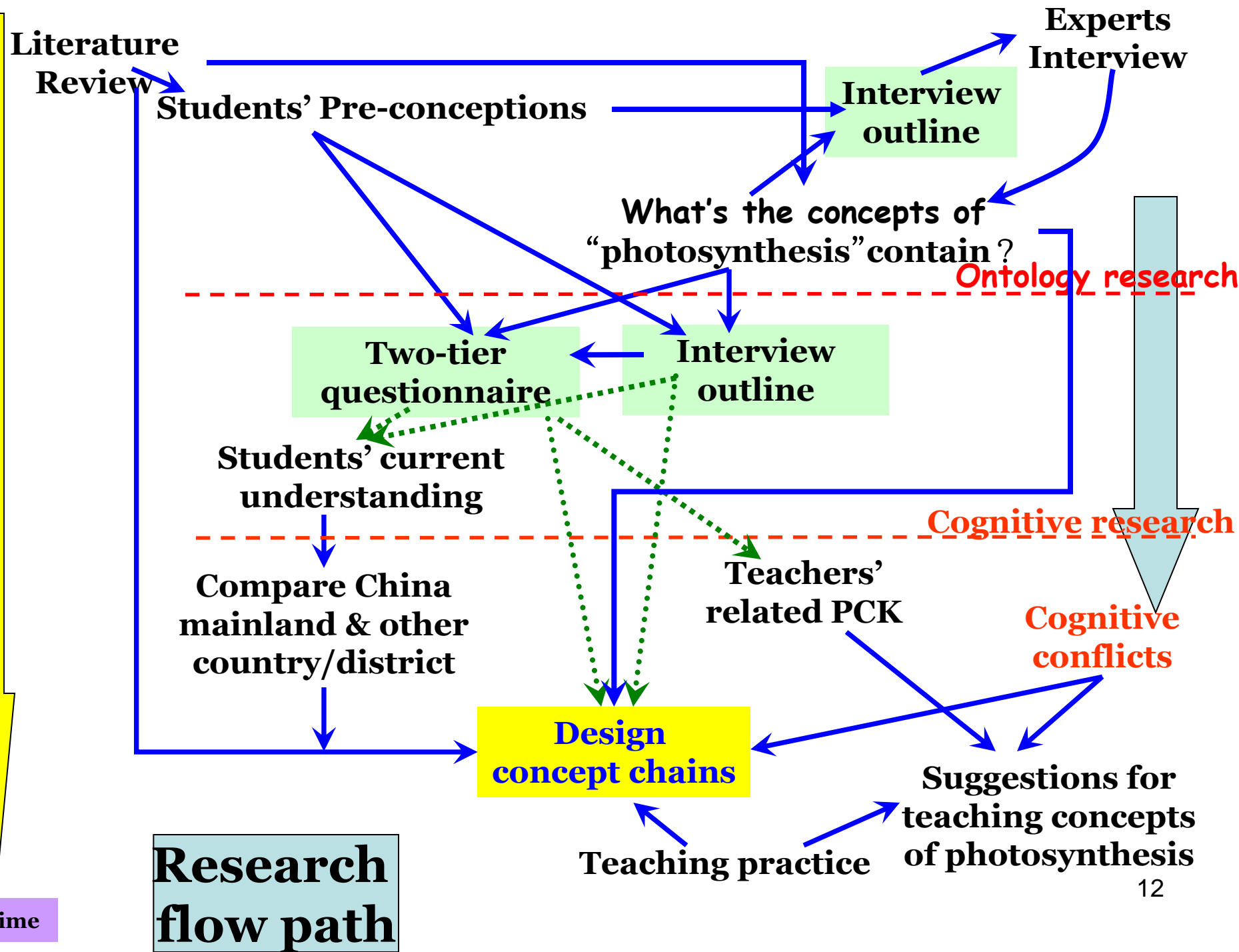
III. What teachers know about students pre-conceptions about “photosynthesis”?

1. Whether teachers know students' pre-concepts about photosynthesis?
2. What concepts need to construct when we want students' change their pre-concepts?

Research Questions

IV. What's the effect of using concept chains to design teaching plan?

1. What concept chains should be based on the analysis of concepts ontology and curriculum standards?
2. What's the gap between concepts ontology and students current cognition?
3. What learning situation should be designed based on these gaps?
4. Whether teaching behaviors conform to the teaching plan?
5. Whether students who learn photosynthesis through concept chains change their pre-conceptions compared with control group?



Research design

Sample, tools, methodology

I . What the label “photosynthesis” represents?

1. What the meaning of the label “photosynthesis” contain?
2. What's the relationship of these concepts related to photosynthesis?

tools : experts' interview outlines based on literature review, using concept chains to represent experts idea about the connection among concepts.

sample : curriculum standards of china mainland and other countries/districts, our biology textbooks, related literatures and thesis, 3 experts.

method : literature research, interview

Research design

Sample, tools, methodology

II. What are students' current understandings of photosynthesis? For example, in Beijing.

1. What are students' common and different pre-conceptions of photosynthesis between china mainland and other countries/districts?
2. What should we focus on when we design teaching plan of photosynthesis based on these common and different pre-conceptions?

tools :

1. two-tier diagnose test : [design test about photosynthesis concepts.](#)
2. students' interview outline: based on literature research and experts' interview, match with the two-tier diagnose test.

sample : about 150 G10-11 students in Beijing.

method : questionnaire, interview, compare study.

Research design

Sample, tools, methodology

III. What teachers know about students pre-conceptions about “photosynthesis”?

1. Whether teachers know students' pre-concepts about photosynthesis?
2. What concepts need to construct when we want students' change their pre-concepts?

tools :

1. Remove the second tier of two-tiers test, ask teachers which is the possible answer from students and why?
2. Interview teachers about what concepts need to construct concepts of photosynthesis?

sample : biology teachers in senior high school

method : questionnaire and interview

Research design

Sample, tools, methodology

IV. What's the effect of using concept chains to design teaching plan?

1. What concept chains should be based on the analysis of concepts ontology and curriculum standards?
2. What's the gap between concepts ontology and students current cognition?
3. What learning situation should be designed based on these gaps?
4. Whether teaching behaviors conform to the teaching plan?
5. Whether students who learn photosynthesis through concept chains change their pre-conceptions compared with control group?

Tools : 1. two-tier test as pre- and post- assessment and interview
2. Teaching behavior record by video, analysis the correspondence between teaching behavior and design

sample : 2 senior high school bio-teachers in Beijing, two experiment classes, two control classes

method : intervene, questionnaires, behavior observation & analysis

Literatures

- 埃里克森.概念为本的课程与教学[M].北京:中国轻工业出版社,2003.
- 曾琦,苏纪玲,章学云,江昕.概念学习的心理学研究成果及新进展[J].教育科学研究,2006,(4):37-40.
- 陈琦,张建伟.建构主义学习观要以评析[N].华东师范大学学报(教育科学版),1998(1).
- 辞海编辑委员会.辞海[M].上海:上海辞书出版社,1989.
- 海因里希(美).结构的构建:作为社会实践的数学化的形成与功能[A].莱斯利(美)等.教育中的建构主义[M].上海:华东师范大学出版社,2002.
- 胡卫平,刘建伟.概念转变模型:理论基础、主要内容、发展与修正[J].学科教育,2004,第12期:34-41
- 加涅(美).学习的条件和教学论[M].上海:华东师范大学出版社,1999.
- 李高峰.初中生生物学前科学概念的研究[D].北京:北京师范大学,2007:27-37.
- 林达森."运用概念构图之科学教学模式"在高中生物科教学的实证研究[R].台湾:行政院国家科学委员会,民国92年.
- 刘恩山.中学生物学教学论(第2版)[M].北京:高等教育出版社,2003:27,46-52.
-
- 汪玲,郭德俊.元认知要素的研究[J].心理发展与教育,2002,(1):44-49.
- 王燕.北京市房山区高中生关于"光合作用"和"呼吸作用"错误概念的初步研究[D].北京:北京师范大学,2006.
- 维果茨基(俄).维果茨基教育论著选[M].北京:人民教育出版社,2005.
- 吴刚.人的学习是如何可能的[A].高文,徐斌艳,吴刚.建构主义教育研究[C].北京:教育科学出版社,2008.
- 吴娴,罗星凯,辛涛.概念转变理论及其发展述评[J].心理科学进展,2008,16(6):880-886.
- 伍尔福克(美).教育心理学[M].南京:江苏教育出版社,2005:323-335.
- 易国荣.网络化双重情境学习模式对国小学生的真菌概念改变之研究[D].台湾:国立交通大学,民国93年.
- 袁维新.科学概念的建构性教学模式与策略探析[J].教育科学,2007,第23卷第1期:24-30.
- 章士嵘.科学发现的逻辑[M].北京:人民出版社,1986.
- 中华人民共和国教育部.全日制义务教育生物课程标准[M].北京:北京师范大学出版社,2001.
- 中华人民共和国教育部.普通高中生物课程标准[M].北京:人民教育出版社,2003.
- 张颖之.对中学生物学核心概念的研究——以遗传学内容为例[D].北京:北京师范大学,2009:2-33.

Literatures

Alfred, T. Collette. Science Instruction in the Middle and Secondary Schools[M]. Ohio: Merrill Publishing Company, 1989:56.

Amir, R., Tamir, P. In-depth Analysis of Misconceptions as a Basis for Developing Research-Based Remedial Instruction: The Case of Photosynthesis[J]. The American Biology Teacher, 1994, 56(2):94-100.

Anglin, J. M. Word, object and conceptual development[M]. New York: Norton, 1977.

Chi, M. T. H., Slotta, J. D., Leeuw N de. From things to processes: A theory of conceptual change for learning science concepts[J]. Learning and Instruction, 1994, Volume 4, Issue 1:27-43.

Chiu, M. H., Guo, C. J., and Treagust, D. Assessing students' conceptual understanding in science: An introduction about a national project in Taiwan[J]. International Journal of Science Education, 2007, Volume 29:379-390.

.....

Hsiao-Ching She. Concepts of a higher hierarchical level require more dual situated learning events for conceptual change: a study of air pressure and buoyancy[J]. International Journal of Science Education, 2002, Vol. 24, No. 9:981-996.

Hsiao-Ching She. DSLM Instructional Approach to Conceptual Change Involving Thermal Expansion[J]. Research in Science & Technological Education, 2003, Vol. 21, No. 1:43-54.

Ioannides, C., Vosniadou, S. The changing meanings of force[J]. Cognitive Science Quarterly, 2001, 2(1):5-62.

Janet Machin, Janet Varleys, & Peter Loxley. Exploring the use of concept chains to structure teacher trainees' understanding of science[J]. International Journal of Science Education, 2004, 26(12):1445-1475.

.....

Vosniadou, S. Capturing and modeling the process of conceptual change[J]. Learning and Instruction, 1994, 4(1):45-69.

Vosniadou, S., Ioannides, C. From conceptual development to science education: A psychological point of view[J]. International Journal of Science Education, 1998, 20(10):1213-1230.

Thanks !

"Two-tier diagnose test about photosynthesis" design

