CoDiLE (Context Diagram of Learning Experience): A Method for Analyzing Individuals' Learning Experience in Science Centers

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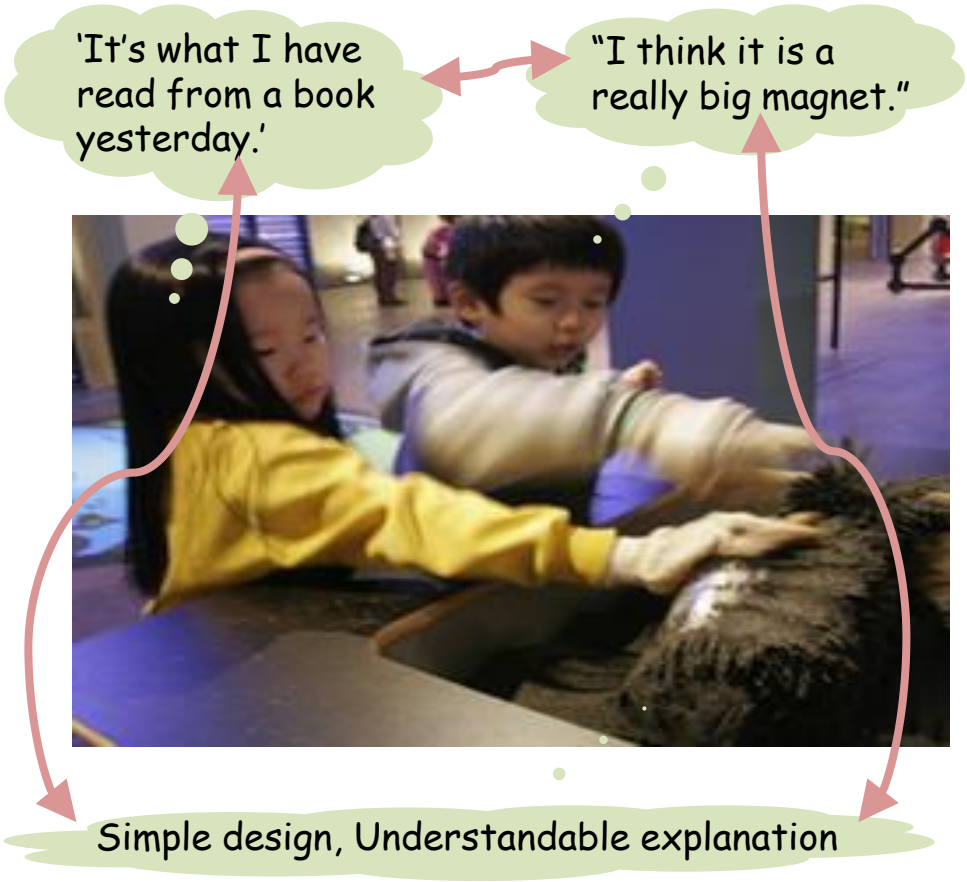
What is happening in Science Centers?

<Situation: A girl and a boy view and interact with a science exhibit>
How can we know whether they are learning or not?



Purposes of the Study

1 Developing CoDiLE

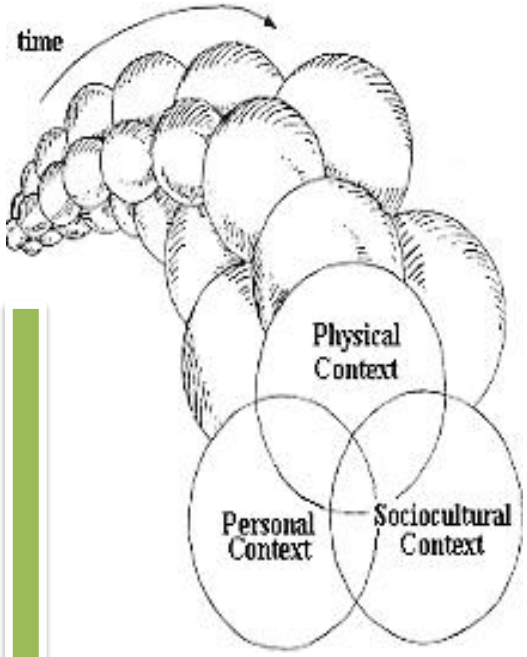
- To develop a tool, the CoDiLE, for analysis of the relationships between individual learning experiences and contextual factors in science centers

2 Applying CoDiLE

- To Explore the applicability of the CoDiLE through by performing case studies

Contexts of Learning in Science Centers

Contextual Model of Learning (Falk & Dierking, 2000)



Context	Factors
Personal	• motivation & expectation • prior knowledge, interests, & beliefs • choice & control
Socio - cultural	• within group sociocultural mediation • facilitated mediation by others
Physical	• Advance organizes and orientation • Deign • Reinforcing events and experiences outside the museum

I identified several contextual factors and placed them in personal, sociocultural, and physical categories.

Learning Experience in Science Centers

Meaning of Learning Experience

- The attention in science education has largely focused on the cognitive domain. However, affective learning needs to be considered as important as cognitive learning in science centers.

I preferred to use the term 'learning experience' rather than 'learning' in order to distinguish it from traditional learning, which mostly refers to cognitive outcomes.

- According to Dewey (1952), learning is the sum of experience and reflection, and can be understood through an analysis of experience

In this study, learning experience refers to all events related to links among contextual factors or between contextual factors and cognitive or affective learning.

Overall Strategy

1. Identifying Contextual Factors
2. Developing the CoDiLE Structure
3. Case Study to Apply the CoDiLE

1 Identifying contextual factors

Falk & Storksdieck (2005)

Personal
- Visit motivation and expectation
- Prior knowledge
- Prior interests
- Prior experience
- Choice and control

Socio-cultural
- Within group social mediation
- Mediation by others outside the immediate social group

Physical
- Advance organizers
- Orientation to the physical space
- Architecture and large-scale environment
- Design and exposure to exhibits and programs
- Subsequent reinforcing events and experiences outside museum

Categories of Contexts	Contextual Factors
Personal	① Prior knowledge ② Prior interests ③ Choice and control
Socio-cultural	④ Within group social mediation ⑤ Mediation by other visitors ⑥ Mediation by staff
Physical	⑦ Contents of exhibit ⑧ Design of exhibit ⑨ Exhibition room environment

2 Developing the CoDiLE Structure

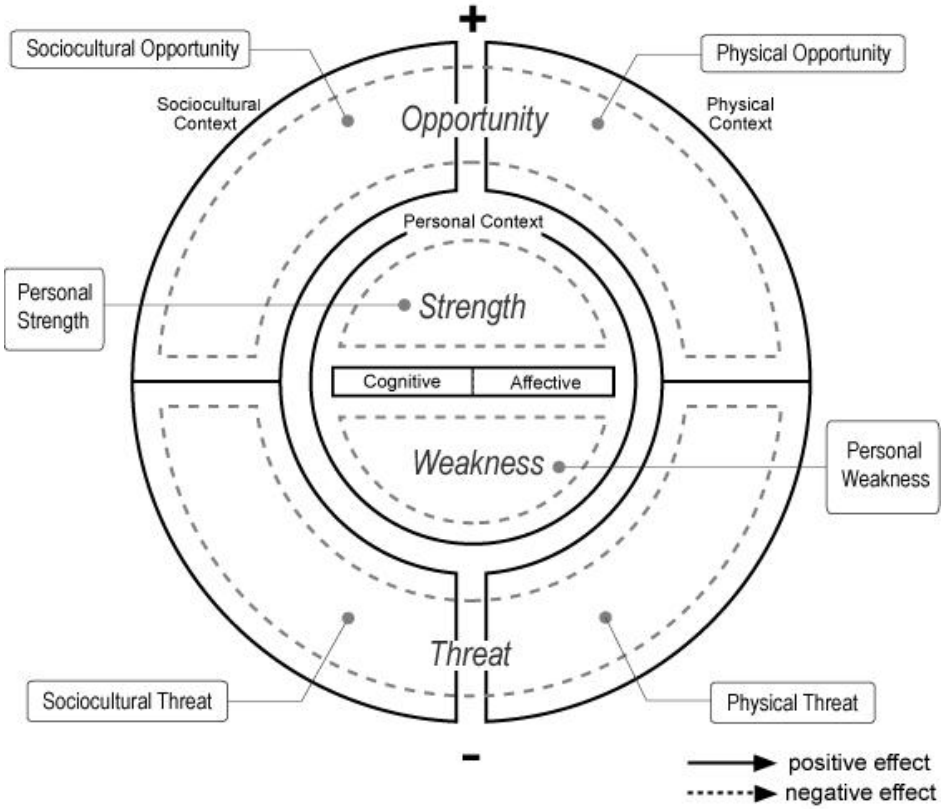
Essential Features of the CoDiLE

- It needed to illustrate, within three context categories (personal, sociocultural, and physical) those contextual factors that affect learning experiences through science exhibits, either positively or negatively.
- It needed to show how the selected contextual factors are linked and how the factors are linked to cognitive or affective learning.
- It needed to represent synthetically the science exhibit learning experience.

2 Developing the CoDiLE Structure

The structure of a CoDiLE

Visitor:	Exhibit:



Behavior	

3 Case Study to Apply the CoDiLE

Data Collection: Participants

- Three seventh-grade students who were members of their school's Science Inquiry Club

	Student 1	Student 2	Student 3
Gender	Boy	Girl	Boy
Behavior in Science Centers	Participated actively with friends Enjoyed new activities	Viewed exhibits with care Completed worksheet in good faith	Active participation when alone When watched by the teacher, passed exhibits
Past Experience in Science Centers	Had some experience, but no specific recall	No previous visits to science centers, but had actively participated in science programs	Visited science centers many times already

- The Science Inquiry Club visited 4 science centers in Seoul
  - Seoul National Science Museum (SNSM)
  - Seoul Education & Science Research Institute (SESRI)
  - Seodaemun Museum of Natural History (SMNH)
  - Electricity Museum (EM)

3 Case Study to Apply the CoDiLE

Data Collection: Process

Stage	What to do
1	Before viewing the exhibits, students answered a questionnaire concerning their conceptions, past experiences and expectations related to the upcoming science center visit.
2	While viewing the exhibits, I and the teacher observed the participants and made a note of the features of behaviors for each student.
3	After viewing the exhibits, the students completed worksheets recording their least and most favorite exhibits and the reasons for those preferences.
4	Within a week after visiting the science center, I interviewed each student to assess the contextual factors that affected their cognitive or affective learning.
5	Within 30 days of interviews, I completed individual CoDiLEs and the teacher and case study students were asked to review the prepared CoDiLEs to ensure accuracy of the final versions.

3 Case Study to Apply the CoDiLE

Data Collection: Interview Protocol

Category	Subcategory	Questions
Science	Conception	- What do you think of science? [probe: Why?]
	Importance	- Do you think science is important? [probe: Why?]
Science Center	Past Experiences	- Have you ever been to *(the science center)* before? [probe: What were the differences between past visit and this one? Have you ever visited other science centers?]
	Expectations	- Had you thought that the visit to *(the science center)* would be interesting or helpful for science learning?
	Satisfaction	- Are you satisfied with the visit to *(the science center)*?
Science Exhibit	Preference	- Why did you choose *(the exhibit)* as the least or most favorite exhibit?
	Understanding	- Why did you evaluate your understanding of *(the exhibit)* as *High(Middle/Low)*?
	Interest	- Why did you evaluate your interest in *(the exhibit)* as *High(Middle/Low)*?
	Contextual Factors	- (e.g.) Did you talk to your friend while viewing *(the exhibit)*? What did you talk? - (e.g.) How did you feel the atmosphere of the exhibition room?

3 Case Study to Apply the CoDiLE

Data Collection: List of 40 CoDiLEs

Places		Student 1	Student 2	Student 3
[a]SESRI	Most Favorite	- Science Story - Jellyfish Bowl - Planetarium	- Foucault's Pendulum - Discharge Sphere - Planetarium	- Catch It - Floating Rings - Electric Generator
	Least Favorite	- Transparent Body - Continental Drift - Insect Experience	- Seems to be Big	- Shadow in Colors - Transverse Wave - Planetarium
[b]SMNH	Most Favorite	- Fishes Living in the - Living Animals - Features of Insects	- Fishes Living in the - Dinosaur - Birth of the Earth	- Asian Elephant - Ground Beetle - Features of Insects
	Least Favorite	- Crying Insects - Volcano Structure - Minerals of Jewels	- Various Rocks - Features of Insects - Various Plants	- Troposphere - Stegosaurus - Function of Forest
[c]EM	Most Favorite	- Kerosene Lamp and Electricity	- Floating Real Image	- Fleming's Principle
	Least Favorite	- History of the Electrical Industry	- Measuring Electric Field	- History of Energy

[a]SESRI, the Seoul Education & Science Research Institute.
[b]SMNH, Seodaemun Museum of Natural History.
[c]EM, Electricity Museum.

3 Case Study to Apply the CoDiLE

Data Analysis: Interview → Drawing CoDiLE

Interview with *Student 1* concerning SESRI *Planetarium*

R: You chose the planetarium as the most favorite exhibit at SESRI. Can you tell me what did you like?

S: Frankly, I did not know about stars very well. But I can have better understanding.
→ ① **Lack of prior knowledge of stars**

R: What did you understand?

S: Some types of constellations or something.
→ **Cognitive learning (positive effect)**

...

R: Did you understand the whole explanation about types of constellations ?

S: Because it was quite detailed, I almost understood the whole explanation of the exhibit.
→ ⑦ **Detailed explanation about constellations**

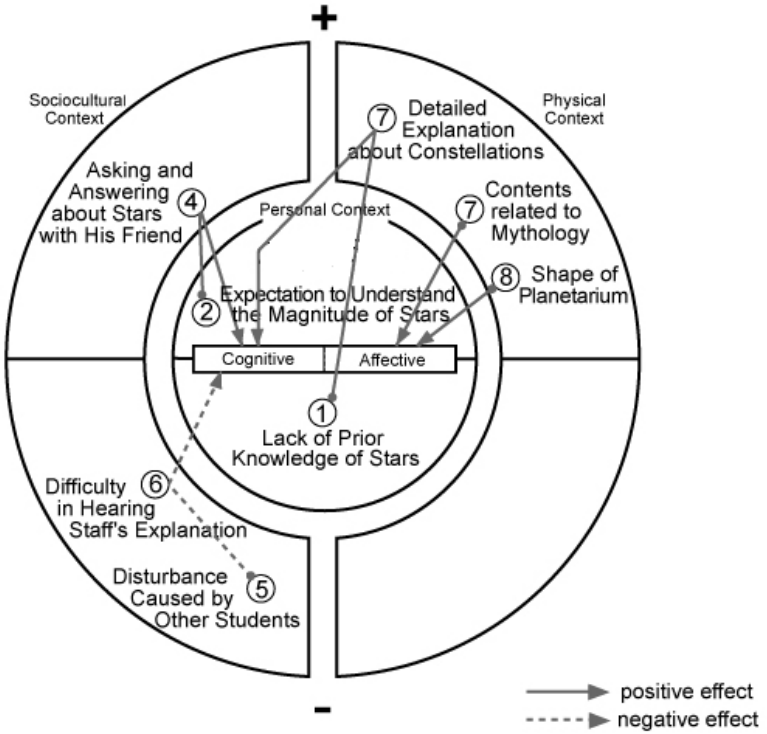
① Lack of prior knowledge of stars
→ ⑦ Detailed explanation about constellations
→ Cognitive Learning (positive effect)

3 Case Study to Apply the CoDiLE

Student 1's CoDiLE of the Planetarium at SESRI

CoDiLE (Student 1, Planetarium)

Visitor: Student 1	Exhibit: Planetarium (SESRI)
• Understanding: Middle, Interest: High • He thinks that science centers are novel. • He prefers to view exhibits with his friends. • It was his first time seeing the Planetarium.	• It shows the constellations in different seasons and tells the mythology related to them. • Reservation is required in advance to see it. • 120 visitors can view it at a time for 30 minutes.



Behavior	• He viewed the Planetarium before finishing viewing general exhibits in SESRI because of the request of the staff. • He was uncomfortable since he was surrounded by students from another school. • He complained about the loud atmosphere since many students made noise and teachers advised them to be quiet repeatedly. • Seeing the Planetarium, he wanted to know the exact meaning of magnitude of stars. So he asked his friend about it and they talked about other characteristics of stars.

3 Case Study to Apply the CoDiLE

Data Analysis: Interview → Drawing CoDiLE

Interview with *Student 2* concerning EM *Floating Real Image*

R: You chose the Floating Real Image as the most favorite exhibit at EM.

S: I put my hands on the image repeatedly. It looked like a real light bulb, however, my hands passed through it.
→③ **Putting hands on the image repeatedly**
→⑧ **Image that she can see but cannot catch**
It was interesting and novel
→ **Affective learning (positive effect)**

R: Have you ever seen similar things?

S: I saw an exhibit, in which the image of a ring was floating in the air, at SNSM. At that time, it was really interesting to me. … Thanks to a good memory, I viewed the exhibit [Floating real image] carefully.
→② **Concerns from the past experience of similar exhibit**

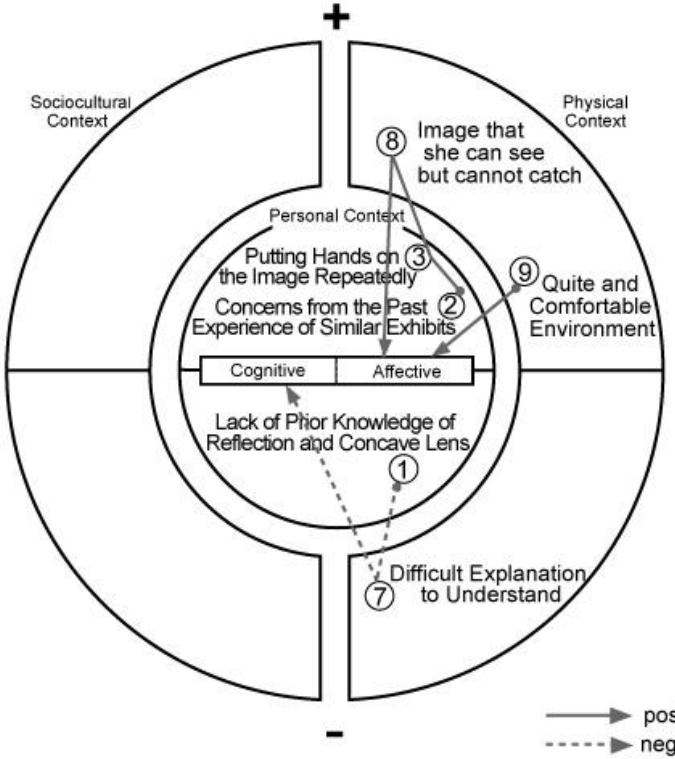
② Concerns from the past experience of similar exhibit
→ ③ Putting hands on the image repeatedly
→ ⑧ Image that she can see but cannot catch
→ Affective Learning (positive effect)

3 Case Study to Apply the CoDiLE

Student 2's CoDiLE of the Floating Real Image at EM

CoDiLE (Student 2, Floating Real Image)

Visitor: Student 2	Exhibit: Floating Real Image (EM)
• Understanding: Low, Interest: Middle • She thinks that science is interesting and important. • She expected that exhibits in the Elecrticity Museum would be difficult since she had little prior knowledge of the electricity.	• It shows the real image of a light bulb which is floating in the air, using two concave lenses. • The panel explains the principle of the exhibit with the picture of ray tracing of light. • It is located in the center of the exhibition room.



Behavior	• She had no sooner found out the exhibit in the museum than she put her hands on the image of the bulb which was floating in the air. • Even though she had seen the similar exhibit before, she wondered about the exhibits. • She tried to understand the principle seeing the explanation on the panel.

3 Case Study to Apply the CoDiLE

Data Analysis: Interview → Drawing CoDiLE

Interview with Student 3 concerning SESRI Planetarium visit

R: You chose the planetarium as the least favorite exhibit at SESRI. Can you tell me the reason?

S: Because I had seen it before. ... I knew most of the contents.
→① **Prior knowledge of constellations**

...

R: The planetarium showed seasonal constellations. Was it the same as you had seen before?

S: I think it was almost same. There was no new information to me.
→⑦ **Contents without new information**

...

Dare I say it, I don't want to see it again
→ **Affective learning (negative effect)**

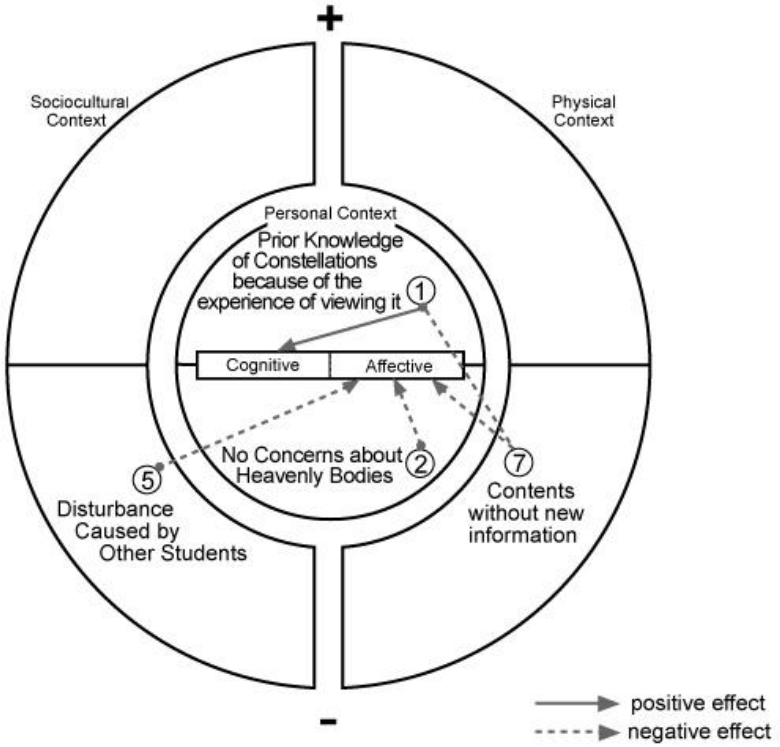
① Prior knowledge of constellations
→ ⑦ Contents without new information
→ Affective learning (negative effect)

3 Case Study to Apply the CoDiLE

Student 3's CoDiLE of the Planetarium at SESRI

CoDiLE (Student 3, Planetarium)

Visitor: Student 3	Exhibit: Planetarium (SESRI)
• Understanding: High, Interest: Low • He likes science and wants to be a physicist. • He thinks that the science center is not interesting. • It was his second time seeing the Planetarium.	• It shows the constellations in different seasons and tells the mythology related to them. • Reservation is required in advance to see it. • 120 visitors can view it at a time for 30 minutes.



Behavior	• He viewed the Planetarium before finishing viewing general exhibits in SESRI because of the request of the staff. • He was angry since the students from another school made noise. • He had already seen the Planetarium at the SESRI 2 years ago. Even though the contents have been changed, he felt similar and boring. • Seeing the exhibit, he did not talk with anybody at all.

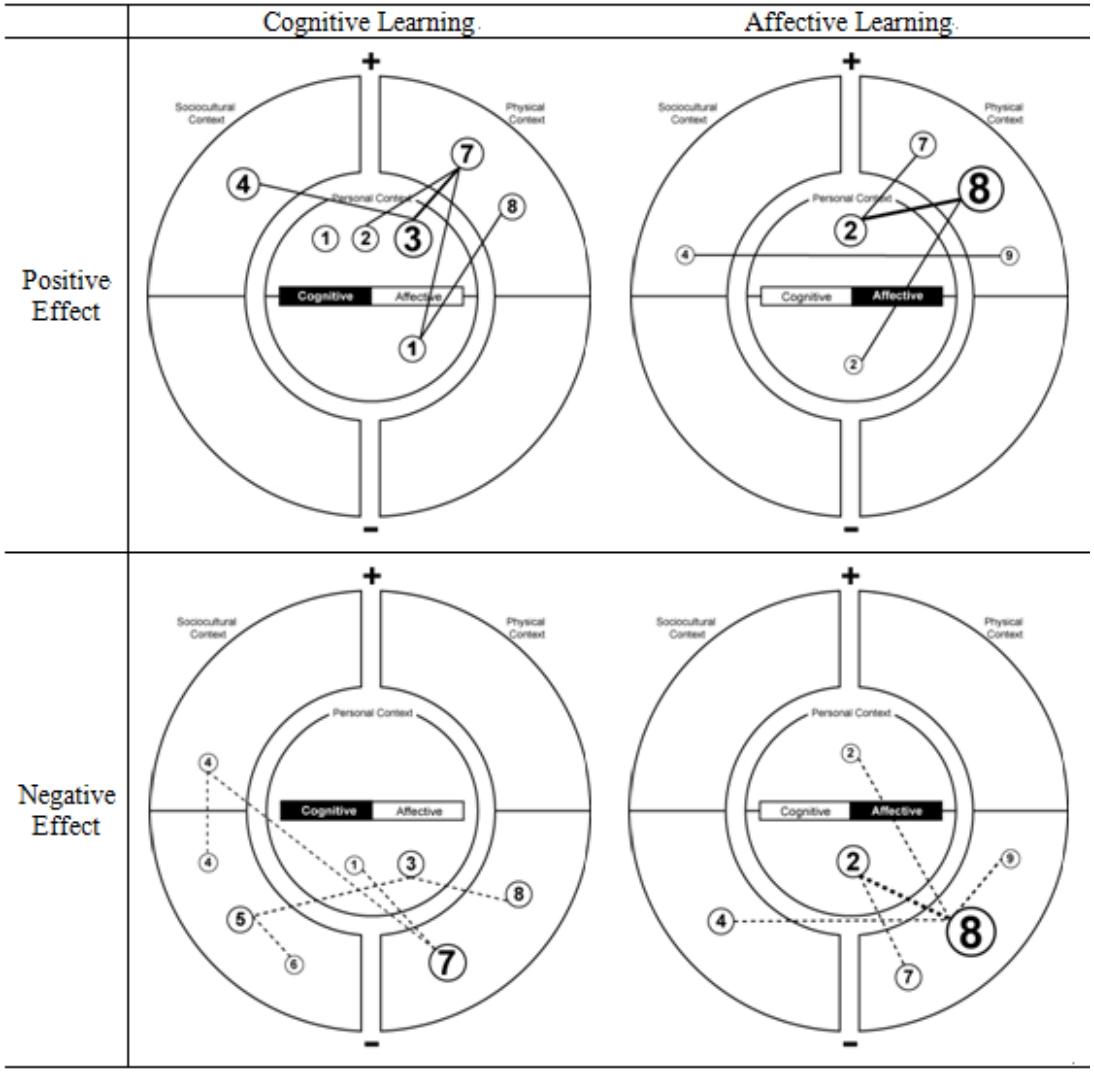
3 Case Study to Apply the CoDiLE

Data Analysis: Distinct CoDiLE Linkage Patterns

- All the contextual factors' links were classified into four classes of contextual factor links.
  - **CoPo** : links that affect cognitive learning positively
  - **CoNe** : links that affect cognitive learning negatively
  - **AffPo** : links that affect affective learning positively
  - **AffNe** : links that affect affective learning negatively
- The contextual factor links within each class were drawn together on the concentric circles for each student.
  - **Size of the number** : relative frequency of the factor
  - **Thickness of the line** : relative frequency of the link between factors

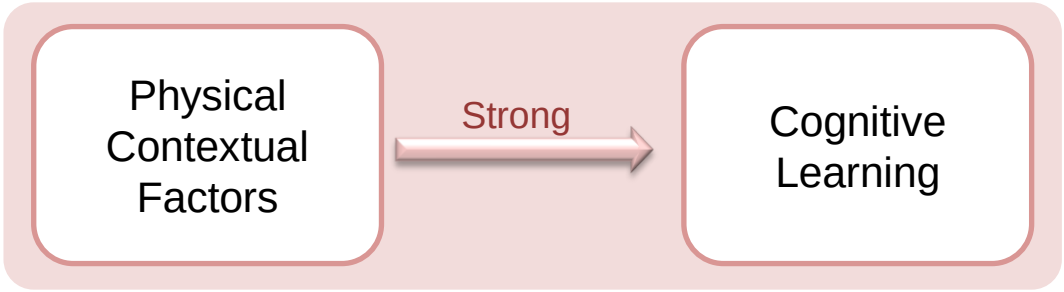
CoDiLE Linkage Patterns for Student 1

The contextual factors' links in student 1's CoDiLEs



CoDiLE Linkage Patterns for Student 1

What I have known about Student 1 from his CoDiLEs

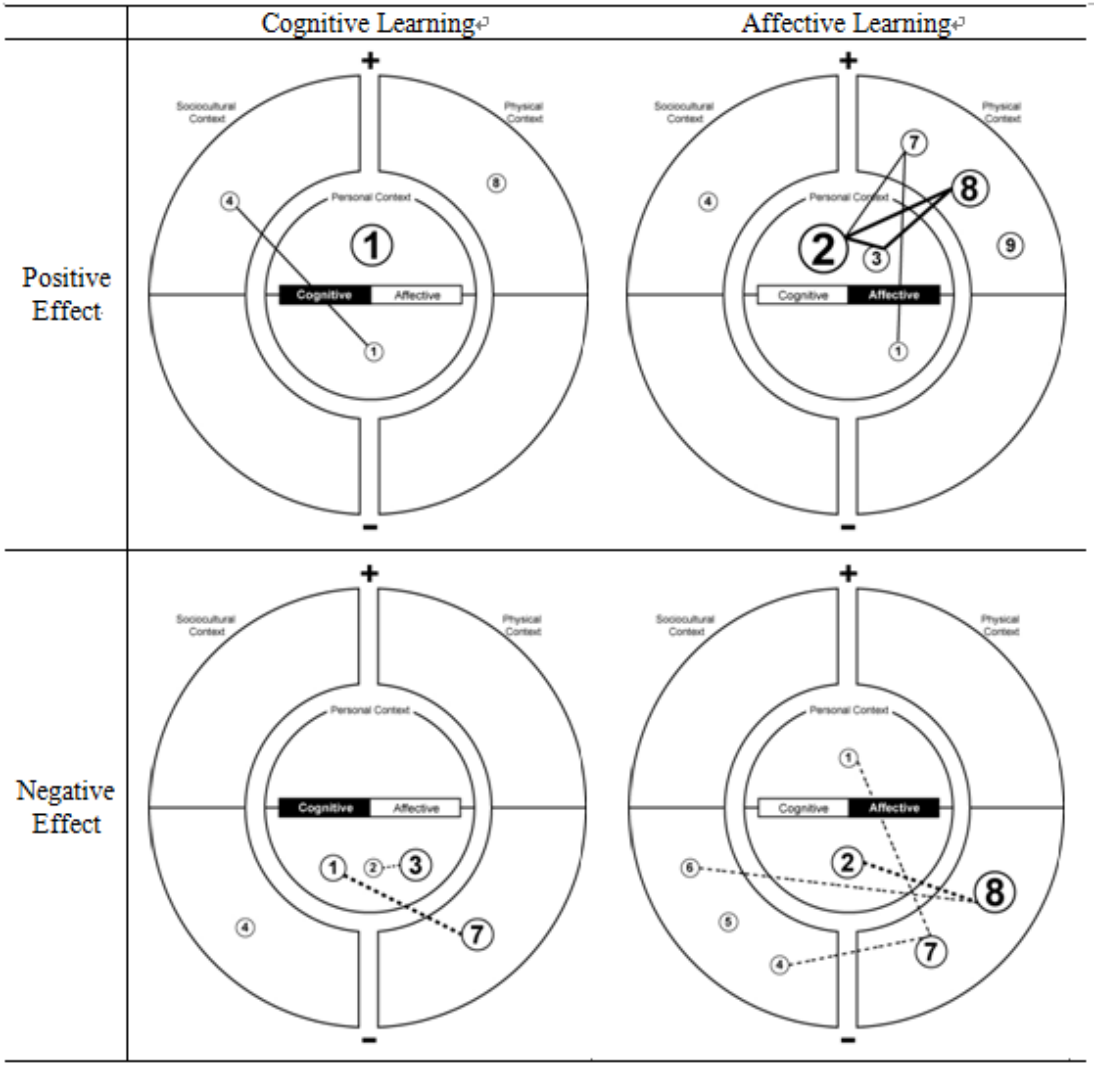


- "I am interested in science, but have never thought about doing various activities concerning science or gaining scientific knowledge in science centers."

- He was not attentive to the exhibit when he was not interested in the contents or had difficulties in understanding the contents or was not fascinated by the exhibit design.

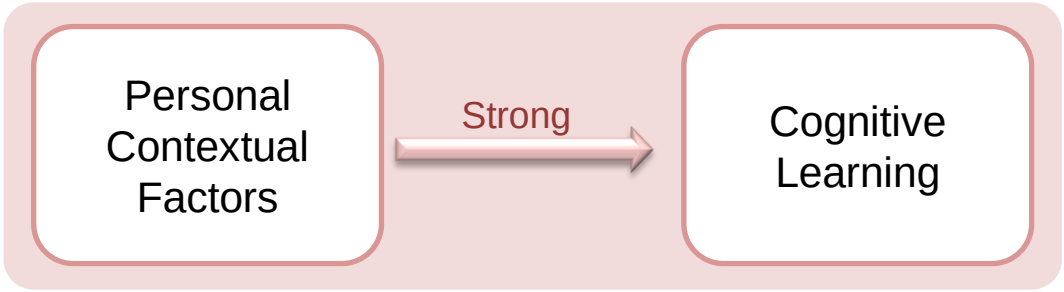
CoDiLE Linkage Patterns for Student 2

The contextual factors' links in student 2's CoDiLEs

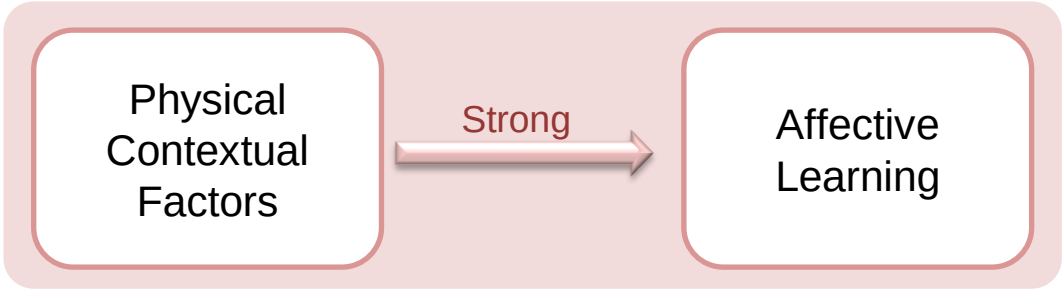


CoDiLE Linkage Patterns for Student 2

What I have known about Student 2 from his CoDiLEs



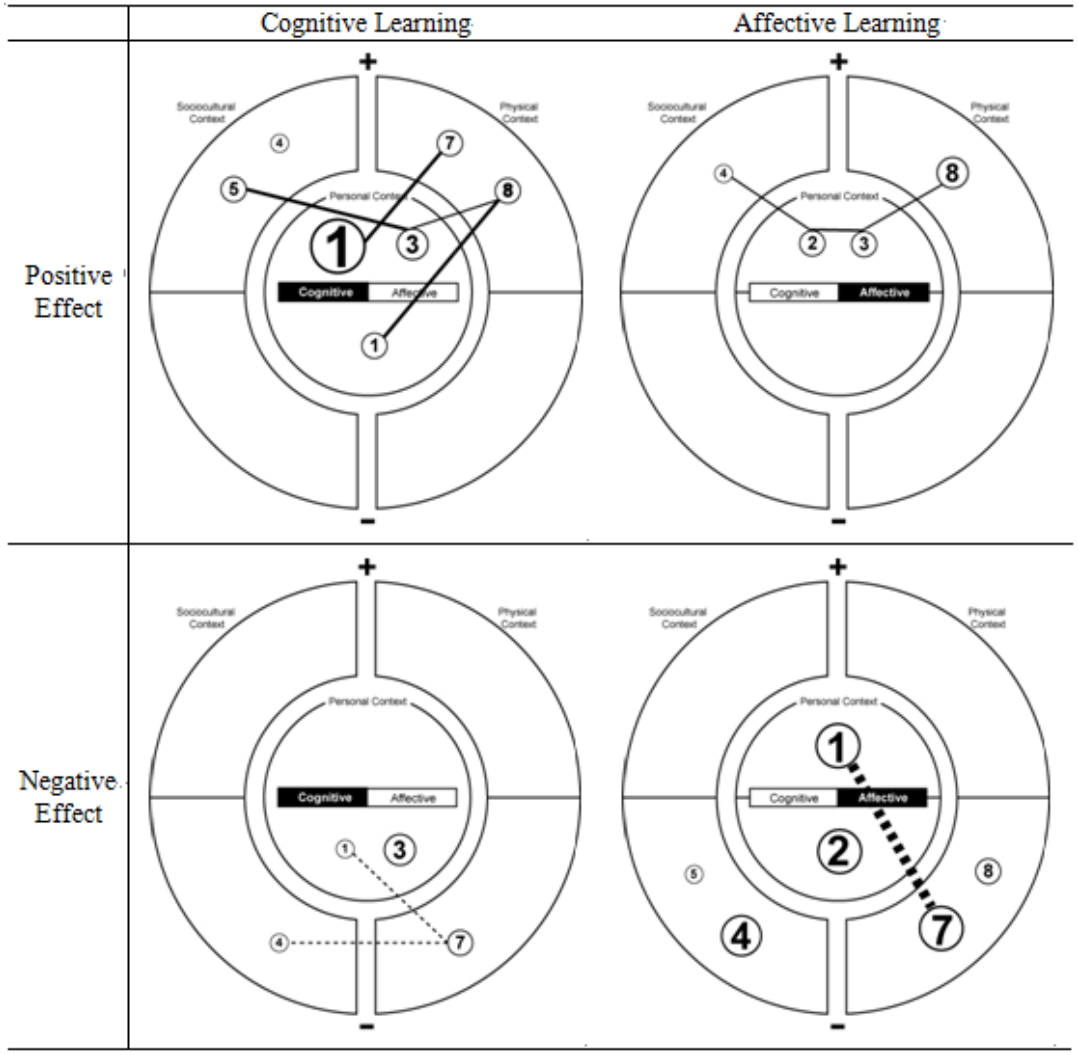
- She expected to do various science activities and gain scientific knowledge and new information in science centers.



- She showed quite different preference toward the exhibits according to their contents.

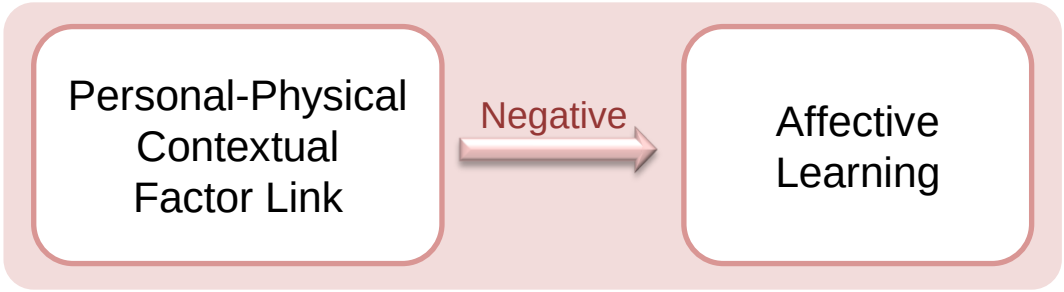
CoDiLE Linkage Patterns for Student 3

The contextual factors' links in student 3's CoDiLEs



CoDiLE Linkage Patterns for Student 3

What I have known about Student 3 from his CoDiLEs



- He had many experiences of visiting science centers. Thus there were lots of exhibits he had already seen.
- He was not interested in the exhibits which did not contain any new information.
- This feature highlights the necessity to review and amend science center exhibits regularly to maintain or improve visitors' affective learning experiences.

Conclusions and Implications

Insights into Learning Experiences in Science Centers

- Students obtained cognitive and affective learning experiences through links among a variety of contextual factors.
- Each student exhibits a distinctive pattern of contextual factors and factor links.
- Relationships among contextual factors may be more important than characteristics of each contextual factor in understanding learning experiences.

CoDiLE is particularly useful for illustrating, systematically and synthetically, the complex nature of learning experiences in science centers by its ability to show relationships among contextual factors.

Suggestions for Further Research

Exhibit Evaluation

- Exhibit should be evaluated considering context. Multiple CoDiLEs for a single exhibit can be used to evaluate exhibits.

Self-drawing

- The activities of drawing CoDiLEs can be used for visitors to facilitate reflective thinking concerning learning experience in science centers.

Theoretical Model

- Theoretical model that explains learning experiences in science centers can be developed using the findings from CoDiLE researches.