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Effects of Case-Based E-Learning on Second-Year College Students' Personal Epistemic Beliefs and Problem-Solving Abilities:

Ill-Defined Environmental Engineering Design Problems

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Contents

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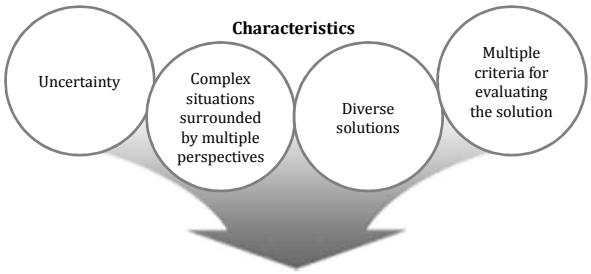
Introduction

Ill-Defined, Real-World Problems



Students need different abilities and skills for ill-defined, real-world problems

(Jonassen, 1997, 2000; Kitchener, 1983; Shin, Jonassen, & MaGee, 2003; Schraw, Dunkle, & Bendixen, 1995; Woods, 1983)

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Theoretical Framework

Personal Epistemic Beliefs

Definition

One's beliefs about knowledge, knowing, and learning
(Hofer & Pintrich, 2002)

Personal Epistemic beliefs **vs.** Learning

- What is knowledge?
- How is knowledge constructed?
- How is knowledge evaluated?
- Where does knowledge reside?
- How does knowing occur?

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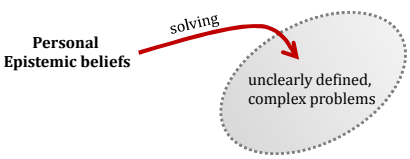
Theoretical Framework

Personal Epistemic Beliefs

Personal epistemic beliefs

could determine

- Approaching the learning process
- Evaluating information
- Constructing new knowledge
- Building arguments
- Creating solutions
- Making decisions in complex, undefined problem space



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Theoretical Framework

Sophomores' Epistemic Positions

Perry's (1968/1999) epistemic development scheme

Dualism
- Black-and-white thinking

Multiplicity
- Acknowledging uncertainty
- Accepting multiple opinions

Contextual Relativism
- acknowledging the importance of contexts for meaning-making

Commitment within Relativism
- adding ethical and moral responsibility and professional commitments to contextual relativism

Theoretical Framework

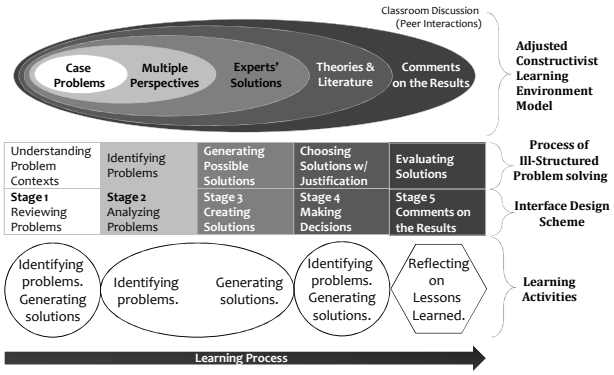
Sophomores' Epistemic Positions

King and Kitchener's (1994) reflective judgment model

Pre-reflective	Quasi-reflective	Reflective Thinking
Believing that knowledge is certain	Acknowledging uncertainty in problems and knowledge	Knowledge is personally constructed from a variety of sources

7

Choi & Lee's (2009) previous study



8

Choi & Lee's (2009) previous study

A student's response to a pre-test

The problem is that Ben is a disruption to the other students in the class. Ms. Williams does not know what to do to solve this problem. Also, there are other students in the class with behavior problems, and this causes even more of an issue in the classroom.

9

Choi & Lee's (2009) previous study

A student's response to a post-test

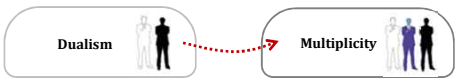
The problem that I see in this case is that Mrs. Williams teaching style and attitude towards Ben is not working with the way that Ben learns. Ben is great at inventing things and working with his hands. He also has a lot of energy. From the description, it sounds like Mrs. Williams does a lot of seated book work in her class and she seems to have given up on Ben, saying that she had "no other option but to keep him in her class." I really believe that it is this type of teaching and thinking by Mrs. Williams that is causing the problem in this case. Also, if the other students are making fun of Ben so much, then this classroom is probably not a strong community of learners, but is a group of individual students coexisting in the same classroom. It sounds as if Mrs. Williams has done little to try to build up a classroom environment in which everyone is accepted, loved, and seen as a vital part of the class. Yes, Ben has problems relating socially to the other students, and seems to have a lot of energy, but it sounds like, instead of looking inwardly at what she could do to improve and attempting to make changes to help her students, she is simply placing the blame on them and trying to get them labeled so they can be moved out of her classroom.

10

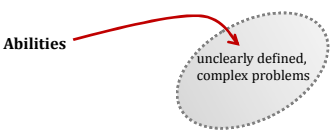
Purpose of the Study

Design and validate a case-based e-learning module that

- Promotes the epistemic development of the second-year engineering students from a dualistic level to a multiplicity level or beyond



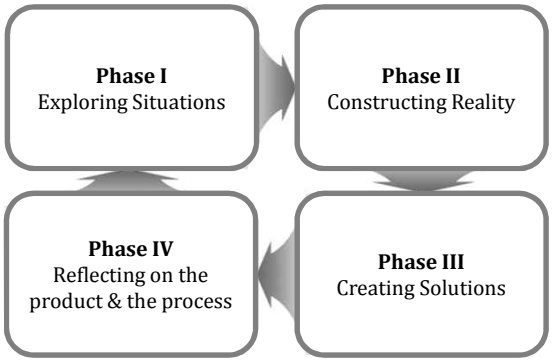
- Improve their abilities to deal with ill-defined, real-world problems



11

Theoretical Framework

Case-Based E-Learning Module



12

Theoretical Framework

Case-Based E-Learning Module

Phase I | Phase II | Phase III | Phase IV

Phase I. Exploring Situations

- A real-world case problem is introduced
- Students build their initial ideas about problems and solutions
- Students may realize the limitations of their thinking
- Students may begin to consider engineering design as a process instead of a product

13

Theoretical Framework

Case-Based E-Learning Module

Phase I | Phase II | Phase III | Phase IV

Phase II. Constructing Reality

- Multiple issues related to the problem are introduced
- Interpretations of the issues by stakeholders and experts are provided
- Content information for related issues is provided

14

Theoretical Framework

Case-Based E-Learning Module

Phase I | Phase II | Phase III | Phase IV

Phase III. Creating Solutions

- Solutions proposed by different experts are provided
- Solutions addressed by multiple perspectives are provided

15

Theoretical Framework

Case-Based E-Learning Module

Phase I | Phase II | Phase III | Phase IV

Phase IV. Reflection

- Students are asked to reflect on the process
- Students are asked to reflect on their solutions

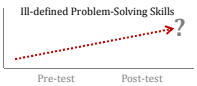
16

Methods

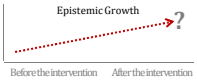
Research Questions

1. Do the learning activities and the given learning resources in each phase of a given case-based e-learning module improve students' ability to deal with ill-defined, real-world problems?

2. Does the overall learning experience with a given case-based e-learning module improve students' ability to deal with ill-defined, real-world problems?



3. Does the overall learning experience with a given case-based e-learning module promote students' epistemic growth?



17

Methods

Implementation

Course Title

Introduction to Environmental Engineering and Sustainability

Participants

31 students

Timeline

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Pre-test — 12 Week Implementation — Post-test

18

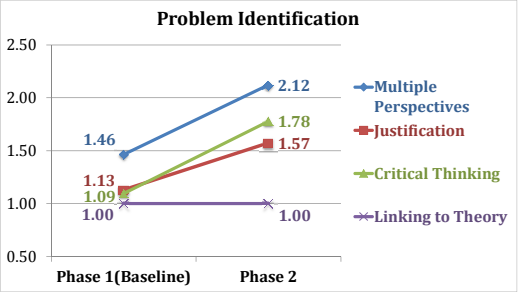
Methods

Research Design

1. **Pre-test**
   - Epistemic belief survey
   - Transfer of problem solving skills test
2. **Case-based E-learning Module**
3. **Post-test**
   - Epistemic belief survey
   - Transfer of problem solving skills test
   - Perceived learning experience survey

Results

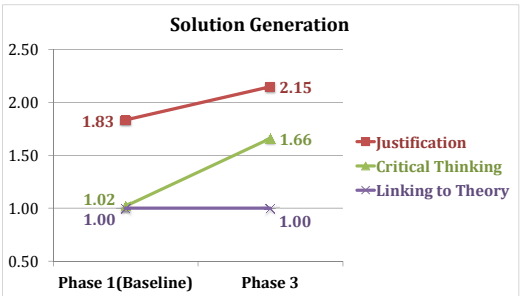
Gain Test: Problem-Solving Skills



Time main effect [$\Lambda = .23$, $F(1, 23) = 78.67$, $p = .000$, $\eta^2 = .78$]

Results

Gain Test: Problem-Solving Skills



Time main effect [$\Lambda = .23$, $F(1, 23) = 78.67$, $p = .000$, $\eta^2 = .78$]

Results

Gain Test: Problem-Solving Skills

Sample of a student's response

Problem Identification in Phase 1 (Baseline)

According to the given situation, Sarah and her family is going through a tough time financially. Her mom couldn't find work easily and the job that Sarah has at a restaurant could also be revoked or the hours might be reduced. Sarah also goes to college and needs to study for a better future of her own.

Multiple Perspectives: 1; Justification: 1; Critical Thinking: 1; Linking to Theory: 1

Problem Identification in Phase 2

The issue that is being explained in this scenario is a very complex issue that is bounded by some social, economic, political, resource availability, and other issues. Thus when you consider the given case from all these different aspects, you can see how this problem is not just for one family but rather a structural problem that includes many other facades and thus an engineering and societal issue overall that needs to be changed or fixed.

Multiple Perspectives: 2; Justification: 1; Critical Thinking: 2; Linking to Theory: 1

Results

Transfer Test

Problem Solving Skills:
- no significant improvement
- no significant Time main effect [$\Lambda = .87$, $F(1, 23) = 3.36$, $p = .080$, $\eta^2 = .13$]

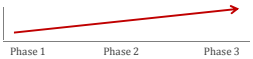
Sub section: Personal Epistemic Beliefs:
- no significant change
- no significant Time main effect [$\Lambda = 1.00$, $F(1, 19) = .04$, $p = .85$, $\eta^2 = .00$]

Conclusion

Discussions

Problem-Solving Skills

- Gain test



Problem-solving skills improved as students went through the four phases of learning activities in the learning module.

- Transfer test

Problem-solving skills fail to improve when asking students to solve another new problem.

Epistemic Belief

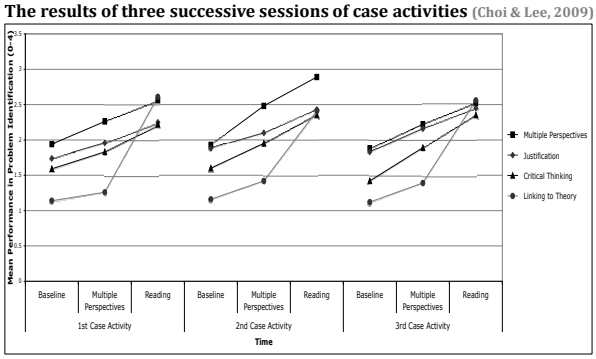
- Transfer test

No change in the students' epistemic growth before and after the case intervention.

Conclusion

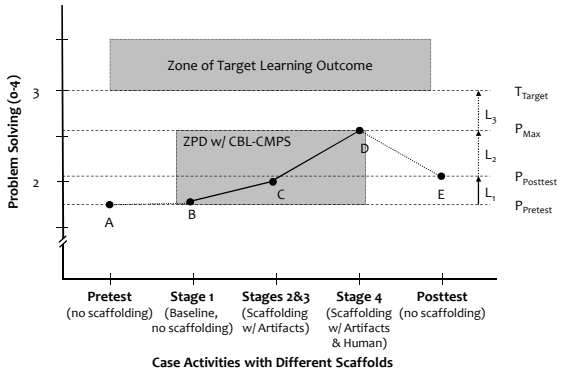
Discussions

The results of three successive sessions of case activities (Choi & Lee, 2009)



25

Choi & Lee's (2009) previous study



26

Conclusion

Implications

1. **One session of case-based learning experience** may not be enough for students to
   - internalize their independent problem-solving skills
   - change their epistemic beliefs
2. **More cases** should be provided
3. Cases should be **smaller** to be completed **in a short period of time** (3 to 5 hours of learning) – portability

27

Thank you

Contact Information for Further Questions

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