From *Limen* to *Lumen*: Computing Students in Liminal Spaces

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Outline

• Background: Threshold Concepts
• Research Question(s)
• Methodology
• Results
  • Partial Understanding
  • Time and Oscillation
  • Emotions
  • Mimicry
  • Crossing the Threshold
• Discussion
• Conclusions
Threshold Concepts (Meyer, Land)

Core concepts in a discipline that are

• Integrative
• Transformative
• Irreversible
• (often) Troublesome
• Mark the boundaries of a field
Value of threshold concepts

- Provide focal points within the curriculum
- Identify important relationships among concepts in the discipline
- Identify places where students are likely to have problems
Liminal spaces: original context

Places where the individual
- Is being transformed
- Acquires new knowledge
- Acquires a new status and identity within the community
Liminal spaces: original context++

The process of traversing these spaces may:

• Take time, and involve oscillation between old and new status

• Involve emotions of anticipation and anxiety

• Involve mimicry of the new status
Research Question(s)

Is this a “useful metaphor in aiding our understanding of the conceptual transformations students undergo” in learning computing?

Do we see evidence of students being in liminal spaces as they are learning threshold concepts in computing?
Previously...

Based on interview data with 14 graduating students (6 institutions, 3 countries), we (Boustedt et al. 2007) identified 2 threshold concepts: Object-oriented programming and Memory/pointers.

Concepts to discuss chosen by students--OOP and memory/pointers discussed in depth in 9 of 14 interviews.
Methodology

• Extract all of the interview discussion related to OOP and Memory/pointers
• Re-analyze all interviews relative to liminal space characteristics
• Have individuals tag quotes independently, then resolve differences through discussion
Results

- Partial understandings
- Time and oscillation
- Emotions
- Mimicry
- Crossing the threshold
Partial Understanding

There are a number of different aspects to understanding a concept

• Abstract understanding
• Concrete understanding
• Relating abstract concept to implementation
• Rationale
• Application
Partial Understanding++

Abstract understanding:

“I can still remember that I tried to do operations on the classes … but I think I was trying to let the lamp shine or don’t shine by doing something with the lamp class instead of with the lamp object.”
Partial Understanding++

Concrete understanding without abstract:

“I’m pretty good at Java, but the interface concept is a little strange…And to explain that to someone, I don’t think I can do it, but I can use the term and I can use interfaces.”
Partial Understanding++

Relating abstract concept to implementation:

“There’s just some aspects to it that just seem to remain kind of mysterious to me at the programming level. Not the concept level, not the theory level, not the technology level but at the kind of code nuts and bolts level ... It’s not that I don’t understand what I’m trying to accomplish it’s just getting the syntax of the details right.”
Partial Understanding++

Rationale:

“I didn’t understand why we needed pointers when references worked perfectly well beforehand. I didn’t understand the power of pointers and I guess I just didn’t see the purpose of declaring variable int*.”
Partial Understanding++

Application:

“it took a long time to understand how object oriented programming works, but then once I understood it more or less, the basic concept, I still couldn’t use it, it wasn’t usable because I didn’t know what to apply to my problems..”
When I finally did make the understanding of Memory/pointers, which actually took about two to three years.

Object oriented programming was one thing for example that took a long time before it clicked. It took perhaps two years before it was completely in-place.
“...most of the time it’s just iterates on the outside of the knowledge spiral...I have to refresh the knowledge I learned recently more often, but some things I have to go back and refresh maybe the real basics of what it’s all about.”
Emotions  (Meyer and Land 2005)

• Students may experience “difficulty and anxiety” when learning threshold concepts.

• Liminal space may be “problematic, troubling, and frequently involve the humbling of the participant”
Emotions

“It just seems like it’s been such a long and horrible road over pointers and that object oriented thing. That’s just been my nemesis the whole way through and I don’t remember anything else being that difficult.”

“Another thing, that was very frustrating. I’m usually quick to understand things.”
“While I was stuck they [pointers] were a nightmare and I hated them. After I figured them out, they were very cool and useful.”

“And then when I do get it to work, it’s almost like these people that run a 25-mile marathon… like that high or whatever. I get that when I solve the problem. I get real souped, screaming in my room.”
“I have so much trouble with that overload asterisk and there’s that – is it asterisk, ampersand symbol or whatever. Never got that. Never had a clue. I just copied it. Yeah, it really gave me trouble..”
Crossing the Threshold

“But I just remember at that moment like it just kind of … made sense, … I don’t know what about it made sense. … I did get it before. I saw what was going on. But I just didn’t feel like I had the control … till I saw it.”

“I think I should know why information hiding is important but I can’t think of it now.”
Discussion

• Multiple aspects of understanding, no single path, not sequential
• Time yes, oscillation not so clear
• Emotions run high
• Mimicry is common—good or bad?
• We push abstract, students need concrete
Discussion++

- Insights about time, emotions, non-standard paths, abstract v. concrete — important lessons for educators
- Students may not know when they have crossed the threshold
Conclusions

• Liminal space is a useful metaphor for the process of learning transformative concepts

• In addition to the “standard” features of liminal spaces, we have identified some that may be specific to computing
Thanks to:

- The student interview subjects
- Jonas Boudedt and Mark Ratcliffe: design, data collection, and initial analysis
- The Department of Information Technology, Uppsala University
- The Department of Computing Science, Umeå University
- Sally Fincher, Josh Tenenberg, and NSF (under DUE-0243242) for providing workspace at SIGCSE 2006 and 2007
Thank you!
Interview semi-script

5. Speaking of learning Computer Science, could you tell me about something where you were stuck at first but then became clearer? (subject answers <X>.)

6. Can I start by asking you to tell me your understanding of <X>?

7. Assume that you were explaining <X> to someone just learning this material, how would you do it?

8. Tell me your thoughts, your reactions, before, during and after the process of dealing with <X>.

9. Can you tell me what helped you understand <X>?

10. Can you describe how you perceived/experienced <X> while you were stuck and how you perceived/experienced it afterwards?

11. Based on your experience, what advice would you give to help other students who might be struggling with <X>?

12. Please tell me what other things you need to understand in order to gain a good understanding of <X>.

13. Can you tell me how your understanding of <X> has affected your understanding of other things?

14. Was your understanding of <X> something that you had to keep reviewing or having learned it once were you OK with it?

15. Describe how and in what context you have used <X> since you learned it?

16. Is there something more you want to tell me about <X>?