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# ***Illuminating the student experience within the liminal space: exploring data-driven learning design for negotiating troublesome concepts***

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## **Abstract**

This study explored how the Knowing and Reasoning Inventory (KARI)—a tool for profiling students’ epistemic beliefs—might be used by learning designers to promote students’ conceptual development. The Threshold Concepts Framework (TCF), developed by Meyer and Land (2003), provides a way of considering how students assimilate new knowledge through a process of reworking their existing conceptual frameworks. The liminal space between conceptual thresholds can be uncomfortable when the new concepts are troublesome for learners to incorporate into their meaning frames. A complexity for educators is that a student’s journey through the liminal space will be influenced by his or her beliefs about knowing and reasoning.

The KARI is a quantitative web survey that draws on Baxter Magolda’s (1992) “ways of knowing” interview protocol and Kuhn’s (1991) argumentative reasoning interview protocol. KARI data were collected from 77 students at the University of Northampton in May 2014. Visualisations of these data were used during a structured workshop of university staff, where they were asked to: 1) identify a threshold concept from their discipline or area of interest, 2) list a set of activities or experiences to develop students’ understanding of the concept and 3) to consider how a student’s KARI profile may influence the design of these activities.

While all participants were able to complete these three activities, findings from this study suggested that “threshold concept” *is* a threshold concept for some learning designers. Findings also suggested that some learning designers may not conceptualise learning activities as needing to be personalised for students. Finally, participants, at times, struggled to interpret the visualisations of the KARI data, making it difficult to consider the meaning of these analytics.

## **Keywords**

Knowing and Reasoning Inventory, KARI, epistemological development, threshold concept, learning design, conceptual development, personalisation, learning analytics, visualisations, self-authorship

## **Introduction**

There appears to be several ways of considering conceptual development. Some literature takes the view that changing from having one notion of a phenomenon to having another is an entirely cognitive process that happens gradually as one gets older and is exposed to new information (e.g. Vosniadou, 1994; Merenluoto & Lehtinen, 2004). Other research views conceptual development as a culturally situated activity and examines the influence of socio-cultural factors, including other people, on conceptual change (e.g. Hershkowitz & Schwartz, 1999). Still, other research looks at how individuals move through stages of understanding in their own epistemological development (e.g. Perry, 1970; Belenky et al., 1997). Common across all of these perspectives is the implication that conceptual change occurs when learners arrive at a point of cognitive conflict, a term which also appears in the literature as “stuck places” (Ellsworth, 1997; Land, et al., 2006) and “epistemological obstacles” (cf. Brousseau, 1997). This is the point (or points) at which learners assimilate new information by modifying their existing mental frameworks or through reworking previously held notions of a particular concept.

The Threshold Concepts Framework (TCF), developed by Meyer and Land (2003), provides one way of considering cognitive conflict and conceptual development. A threshold concept is “transformative” in that,

once it is understood, it changes a student’s learning, behaviour, values and sometimes their identity (p. 5). In this sense, it is not possible to unlearn a threshold concept, making the process of crossing a threshold “irreversible”. Grasping a threshold concept is possibly “integrative”, meaning that this new understanding illuminates the “interrelatedness of something”, and “bounded”, meaning it may border “with thresholds into new conceptual areas” (pp. 5-6). An example of a threshold concept in Mathematics is that of a “complex number” and in the subject of Economics, an example is the concept of “opportunity cost” (Meyer & Land, 2006).

Threshold concepts are described as “conceptual gateways”, implying the existence of an in-between or “liminal” space (Meyer & Land, 2005, pp. 373, 375-377). The liminal space between conceptual thresholds can be uncomfortable when the new concepts are troublesome for learners to incorporate into their meaning frames. In the liminal state a learner may “oscillate between old and emergent understandings” (Cousin, 2006, p. 4) and they may be tempted to employ surface learning strategies to avoid this discomfort (Walker, 2013).

A challenge for educators is to present learning contexts that have enough conflict or uncertainty to provide a transformative learning experience, but not so much conflict as to tempt the learner to exit the liminal space (Walker, 2013). An added complexity for educators is that among cohorts of students, there will be “pre-liminal variation” in students’ conceptual understanding (Land et al., 2005, p. 60). Supporting the student in moving from a state of non-knowing to a position of knowing is complicated further by the variation in epistemic beliefs among the cohort (cf. Hofer, 2002).

Would a better understanding of university students’ pre-liminal, epistemic beliefs assist educators in promoting an individual student’s conceptual development? This paper discusses a study that explored how the Knowing and Reasoning Inventory (KARI)—a tool for profiling university students’ epistemic beliefs—might be used by learning designers to help students negotiate troublesome concepts.

## Threshold concepts, epistemic beliefs and learning design

This paper refers to the term *learning design* (or *course design*), to mean the act of creating learning opportunities by way of designing learning activities, facilitating learning experiences and developing learning contexts. The term *learning designer*, in this paper, is used to include all higher education staff who might play a role in learning design: teachers, academic developers, learning designers, learning technologists and those who oversee course approval and review processes.

Land et al. (2006) outlined nine considerations for course design and evaluation in relation to the TCF (see Table 1).

**Table 1: TCF considerations for course design (adapted from Land et al., 2006, pp. 198-204)**

Consideration	Description
1. Look for “jewels in the curriculum”	Identify potentially transformative points in the curriculum where there are opportunities to support a student’s conceptual understanding.
2. Engage students	Find ways to engage students in exploring, explaining, presenting, applying and connecting with new concepts.
3. Develop a “third ear” (cf. Ellsworth, 1997)	Learn to understand what influences a student’s knowing or not knowing, recognising the pre-liminal factors that may attribute to this journey.
4. Support repositioning of selves	Be aware of how conceptual development may require a shift in one’s self in relation to the concept. Consider how and why knowledge may be troublesome and the impact that new insights, once grasped, might have on a student.
5. Encourage metacognitive skills to help deal with uncertainty	Help students develop metacognitive skills for self-regulation that support their liminal experience during times of ambiguity and anxiety.
6. Enable recursive and excursive approaches to learning	Design learning experiences that offer “multiple takes” for grasping concepts. Think of learning as a journey with an intended direction of travel but with scope for deviation and revised direction.
7. Know more about the pre-liminal variation of a cohort	Attempt to understand how different students’ pre-liminal beliefs about a concept affect their advancement through the liminal space.
8. Evaluate generic pedagogy for oversimplification of concepts	Take opportunities to evaluate course design on the basis of whether teaching strategies are effective for threshold development within a particular context.
9. Recognise the underlying episteme of students’ conceptions	Find ways to understand alternative understandings that students may hold of different concepts and help students to understand how these different understandings may influence their ability to grasp new knowledge.

There are implications for each of these nine considerations when thinking about students' epistemic beliefs. As Baillie et al. (2013) pointed out, a learner's conceptual development is 'shrouded in distinctive, epistemic modes of reasoning and explanation' (p. 234). A greater awareness of students' beliefs about the nature of knowledge can illuminate students' conceptual development (Buehl & Alexander, 2001).

Literature on levels of processing and epistemological development in higher education suggest that a student's capacity for knowing and reasoning can be promoted through pedagogical strategies (cf. Perry, 1970; Schommer, 1990). Moreover, theorists such as Kuhn (1991) and King and Kitchener (1994) claim these strategies should be of utmost importance among educators.

The notion that certain teaching strategies can encourage students to develop along a certain trajectory offers an impetus for considering students' pre-liminal ways of knowing and of reasoning. This paper addresses a possible instrument for profiling students' way of knowing and reasoning and explores how learning designers might use such a tool to facilitate students' conceptual development.

## The Knowing and Reasoning Inventory (KARI)

The Knowing and Reasoning Inventory (KARI), developed by Alden Rivers and Richardson (2014), is a web survey that draws on Baxter Magolda's (1992) "ways of knowing" interview protocol and Kuhn and Weinstock's (2002) argumentative reasoning interview protocol. Three demographic questions are also included in the survey to elicit age, gender and educational background. Table 2 shows how these two conceptual frameworks for understanding students' ways of knowing and reasoning might align. A more in-depth literature review is currently being written to contextualise the KARI (see Alden Rivers & Richardson, 2014, for an overview).

Kuhn and Weinstock (2002) classified students as "realists" if they have an absent or very basic understanding of knowledge. Previous research by Kuhn (1991) classified students as "absolutists" if they believe that experts could know or find specific causes of ill-structured problems (i.e. problems with no clear solution). "Multiplists" are students who deny that knowledge is certain but who believe their own view is just as plausible as an expert's (i.e. there are no experts). "Evaluativists" are the most sophisticated thinkers and view knowledge as uncertain but recognise that experts do exist.

Similarly, Baxter Magolda's (1992, 1996) work reported four ways of knowing, ranging from "Absolute", where knowledge is certain and comes from a source of authority, to "Contextual", where knowledge is co-constructed and should be evaluated in terms of the context in which evidence is presented. "Transitional" and "Independent" ways of knowing represent movement along this scale where students start to see the value of their peers and begin to develop skills for self-regulation.

**Table 2: Conceptual framework underpinning the KARI**

<b>Reasoning</b> (Kuhn & Weinstock, 2002)	<b>Knowing</b> (Baxter Magolda, 1996)
Realist	Absolute Knowing
Absolutist	
Multiplist	Transitional Knowing
Evaluativist	Independent Knowing
	Contextual Knowing

The first phase of testing involved an anonymous sample of 77 students at the University of Northampton in May 2014. The sample was recruited through several means, including a link to the survey in the student newsletter and through course tutors, who volunteered to promote the survey. Statistical analyses showed that the KARI has excellent inter-reliability within the set of Knowing questions (Cronbach's  $\alpha = 0.99$ ) and within the set of Reasoning questions (Cronbach's  $\alpha = 0.90$ ). There were some interesting and statistically significant relationships between the Knowing, Reasoning and Demographic questions, which may be the basis of further inquiry. The development and validation of the KARI currently is being reported in a separate piece of work (see Alden Rivers & Richardson, 2014, for contact details).

The data were distilled into several visualisations showing individual students' knowing profiles and reasoning profiles. Four of these profiles were used in the present study to explore how such analytics may assist learning designers in supporting students' conceptual development. These visualisations—or epistemic profiles—are depicted here as Figures 1 to 4.

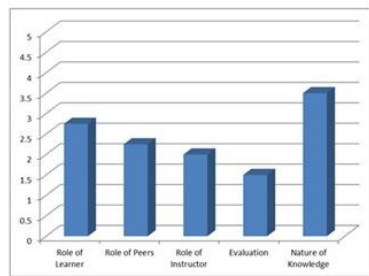


Figure 1: Transitional knower moving toward independent knower

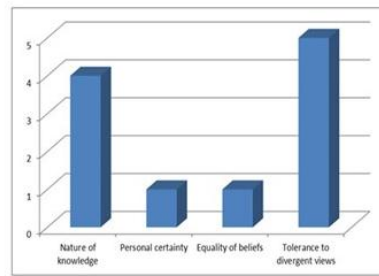


Figure 3: Multiplist moving toward evaluator

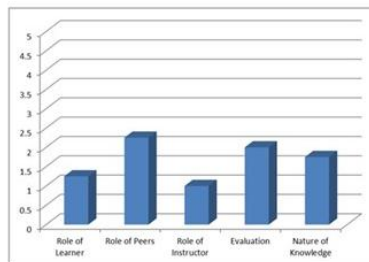


Figure 2: Independent knower moving toward contextual knower

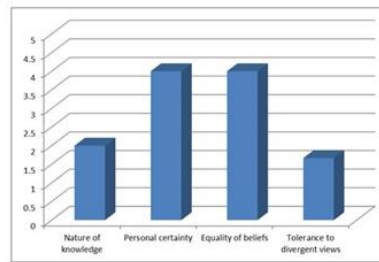


Figure 4: Absolutist moving toward multiplist

Figures 1 and 2 are derived from survey questions that used a reverse Likert scale, meaning that lower scores reflect more sophisticated responses. Figure 1 represents a student who is starting to understand knowledge as uncertain but who is not wholly convinced. This student is beginning to see the value of their peers and of their own skills in influencing their learning but has not developed fully a sense of context in terms of evaluating evidence. Figure 2 represents a student who is advancing to the most sophisticated way of knowing. This student thinks for themselves, values the insights and opinions of others, sees the instructor as someone who promotes independent thinking and evaluates evidence based on the context in which it is presented.

Figures 3 and 4 are derived from survey questions where higher scores reflect a more sophisticated response. Figure 3 reflects a student who is moving toward a sophisticated way of reasoning. They view knowledge as uncertain; they do not perceive themselves to have the right answers and they are highly tolerant of other people's viewpoints. Figure 4 represents a student who views knowledge as certain, is very sure of their beliefs about knowledge and does not value input from others.

## The workshop

Ten members of staff at the University of Northampton participated in a workshop to explore whether epistemic profiles could be influential in shaping learning design for threshold concepts. The sample comprised four academics from various disciplines, one educational developer, two learning designers, one learning technologist, one head of department for learning services and one head of quality, who oversees the approval of new courses and periodic review of existing courses. Six of the participants attended a face-to-face workshop and four of the participants provided input virtually, through an asynchronous, online activity.

Participants were asked to carry out three activities: 1) identify a threshold concept from their discipline or area of interest, 2) list a set of activities or experiences to develop students' understanding of the concept and 3) to consider how a student's KARI profile may influence the design of these activities. The workshop facilitator observed the six face-to-face participants as they worked in pairs to address the questions, offering some verbal input as needed. The facilitator engaged in follow-up email exchanges with the virtual participants to address some of the issues and ideas that emerged from the activity. Three main themes were identified through the observation of and exchanges with these participants.

### **Theme 1: “Threshold concept” is a threshold concept**

For all but two participants (both academics), the first activity (identify a threshold concept) proved challenging. In the face-to-face workshop, the facilitator spent much of the time explaining the notion of threshold concepts and providing examples, from the literature and from her own experience, of such concepts. The three pairs in the face-to-face workshop eventually arrived at concepts related to fields of their own previous study. For example, one team selected *music notation*, based on their background in musical performance. Another team selected the concept of *evidence*, based on their educational background in law. One academic, participating virtually, selected the concept of *learning styles*.

### **Theme 2: Learning is designed for the cohort rather than for the person**

All participants engaged with the second task (list three activities) fairly easily. However, the third task, of considering how they might adapt these activities based on the KARI profile of a student, sparked some initial confusion among all participants. After discussion in the face-to-face workshop, this confusion was overcome and several interesting ideas were generated. The team looking at music notation, for example, commented that a student with a fairly sophisticated profile might learn more effectively if they were encouraged to create their own mnemonic devices rather than memorise one from the teacher.

Comments from the participants while they worked on the third task, as well as written comments from the participants who engaged virtually, suggested that, in practice, they would not design different learning activities for different students.

I would not create different scenarios. I'd use exactly the same activities for both students. The output and subsequent outcome of a single "learning situation" would be different, perhaps, but the scenario for learning would be the same.

Rather, the participants did suggest that they might encourage variation in the way the activity was approached by the student or contextualised by the teacher.

For reasoning profile 2 their discussions should be undertaken with a tutor present in case they are too aggressive about sticking to their own views with other more undecided students.

### **Theme 3: Visualisations of data need to be more meaningful**

A tangent theme emerging from the workshop, was that the distillation of KARI data into a visualisation required a clearer context. As a stand-alone tool, it was difficult for the face-to-face participants to understand what the profiles represented. In the virtual exercise, short interpretations were offered to participants to help them understand the profiles. However, even this attempt to explain the visualisations did not fully support their understanding. One participant commented that “there is too much new information for some folk [sic] to take in”.

## **Conclusions**

Inextricably woven into our conceptual development are our beliefs about knowledge and knowing. Without knowing more about the pre-liminal variation among cohorts, including students’ epistemic beliefs and motivations for studying, it is challenging to design learning that promotes conceptual development effectively. Tools such as the KARI provide some insight, but require further testing and refinement.

Learning designers, as architects of learning activities, experiences and contexts for learning, play a unique role in promoting students’ conceptual development. The findings from this study suggest that all university staff in a position to support learning—teachers, learning designers, learning technologists, educational developers, heads of learning services, heads of quality—may benefit from a richer understanding of conceptual development frameworks, such as the TCF. As a starting point, the notion of threshold concepts could be introduced and cascaded to relevant members of staff as part of an institutional strategy for learning and teaching enhancement.

Understanding learners as knowers and designing opportunities for learners to develop their epistemic beliefs is the cornerstone of promoting self-authorship in higher education (cf. Baxter Magolda, 1999). Current research into personalised web based learning is supported by the notion that there is “no fixed pathway” that fits all learners (see Hulpuş, Hayes, & Fradinho, 2014). As such, findings from this study have implications for researchers and practitioners in thinking about how (or if) learning activities should be personalised.

The potential for data to inform effective interventions for learning underpins the concept and burgeoning field of learning analytics (see Clow, 2013). However, text free visualisations are challenging to devise. This is

problematic when trying to make sense of a large amount of complex data (Whitelock, et al. 2014). Findings from this study suggested that more consideration into how such data sets are distilled into meaningful visualisations is necessary for them to be of use in the learning design process.

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