

**Opening up the portal of understanding:  
Variation theory, key concepts, threshold concepts and critical factors for learning**

Anna-Karin Carstensen<sup>a, b, c</sup> and Jonte Bernhard<sup>b, c</sup>

<sup>a</sup>*School of Engineering, Jönköping University, Jönköping, Sweden.*

<sup>b</sup>*Engineering education research group, ITN, Linköping University, Campus Norrköping,  
Norrköping, Sweden.*

<sup>c</sup>*National Graduate School in Science and Technology Education, ISV, Linköping University,  
Norrköping, Sweden.*

As the title - Opening up the portal of understanding - suggests, we propose that there is a need for investigations into making learning possible. We suggest that a clearer differentiation between “problems” and “potentials for learning” is made. Although many of the studies on threshold concepts also deal with how to make learning possible, there is otherwise a risk that studies end when the problems are found. Our proposal is to distinguish between ways to identify *threshold concepts* and ways to identify what needs to be addressed in order to open up learning spaces. Earlier we have proposed the idea of *key concepts* – concepts which do not just open up for learning of a “particular concept, but also learning of other concepts related to it”<sup>1</sup>.

Earlier research in Science education has for a long time dealt with misconceptions of single concepts, although one of the common objectives in many subjects is “to learn relationships”. The research on threshold concepts is dealing with concepts that are related, and is thus opening up a new dimension of the research on understanding. One important issue discussed in the field of ‘threshold concepts’ is that a threshold is not just any problem a student may have. In the same way a key is not just anything we teach, but something that really opens up the kind of ‘portal’ that is at heart in the framework of threshold concepts.

Ference Marton and his co-workers have developed a theory for learning dubbed ‘variation theory’<sup>2</sup>. Central in this theory is that we learn through the experience of difference, rather than the recognition of similarity. According to variation theory necessary conditions for learning are the experience of *discernment*, *simultaneity* and *variation*.

In the domain of a course in electric circuit theory for engineering students we have tried to explore how a threshold concept may become identified, how we by studying video recordings from labwork we can see a way to what is troublesome within the concept, how the use of variation theory can open up new dimensions in the learning space, thus finding keys to open up the ‘portal’, and how, again by video transcripts, we can evaluate the new learning sequence.

In this research we have found ‘variation theory’ to be a valuable tool for designing for learning after we have identified what is troublesome for students’ to learn. In our paper we will further discuss the relationship between variation theory, threshold concepts and key concepts and show, using examples from our studies, how these ideas can be used in research into the understanding of, and developing potentials for, student learning.

---

<sup>1</sup> Carstensen, A.-K., & Bernhard, J. (in press). Threshold Concepts and Keys to the Portal of Understanding: Some examples from Electrical Engineering. In R. Land & E. Meyer & J. Smith (Eds.), *Threshold Concepts within the Disciplines*. Rotterdam: Sense Publishers.

<sup>2</sup> Marton, F., & Tsui, A. B. M. (Eds.). (2004). *Classroom Discourse and the Space of Learning*. Mahwah: Lawrence Erlbaum.