TEACHING TOPICS

LEARNING RESEARCH SKILLS AS THRESHOLD CONCEPTS

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OVERVIEW

This teaching topic is about improving students' learning of research capabilities. The research showed that students experience thresholds in both research methodology and self-driven learning. Sandor Löwik did the educational research work in a 1 EC introductory part of the premaster course for the Master's programme of Industrial Engineering and Management (IEM). The work in this teaching topic was supported by the Brinksma Innovation Grant (BIG) award.

See www.utwente.nl/big for more information about this Grant.

MOTIVATION FOR THIS WORK

'How can we support and lead students towards deep learning of complex concepts?'

This is a question for many teachers in higher education. Sandor Löwik, a seasoned teacher of social sciences research, has experienced the barriers involved. For example, in the 2017 delivery of module 11 of IEM, he introduced a brief essay assignment and *'expected that the assignment was easy to do, but instead, I initially failed all 60 essays.'*

Next, he gave individual feedback plus a format for the resit test. Guess what?

'*Almost all students passed the second time. I taught them to (only) do a trick!'*

BRINKSMA INNOVATION GRANT

Sandor, an assistant professor at BMS Faculty, is the winner of the first, 2017, Brinksma Innovation Grant.

Sandor worked closely together with Hans van den Berg of CELT, in redesigning, developing, teaching and researching the 1 EC premaster course part. Sandor and Hans already collaborated in IEM M11 for a number of years.

Furthermore, Céline Steenge, a student of the IEM premaster, acted as a partner in the BIG research.

This teaching topic focuses on the research work in the premaster course.

Sandor Löwik
Assistant professor at BMS Faculty
Winner of Brinksma Innovation Grant 2017

A **THRESHOLD CONCEPT** (TC)
IS A SPECIAL TYPE OF CONCEPT.

LEARNING A TC CAN BE **VERY DIFFICULT**,
BUT IF LEARNED,
A TC **TRANSFORMS** THE LEARNER.

FOURIER TRANSFORM

RECURSION

THE WORLD IS A SPHERE

IMAGINARY NUMBERS

OPPORTUNITY COST

Figure 1. The Threshold Concept Tunnel (as a figure of speech)

CONTEXT

Contexts are important. For the premaster, diversity is the key feature. The research competences course is the first – alongside with some other courses – that incoming students take. These students typically are not from the bachelor's programme, IEM. Instead, these students are: from a 'hard sciences' university bachelor, or from a IEM or business administration programme from a university of applied sciences, or from abroad.

This implies that some students are new to social sciences research, while many are familiar with a more traditional pedagogy, and not with the pedagogy of student-driven learning. Also, some students may haven't yet developed their conceptual thinking competence. So, diversity can involve disciplinary background, teaching and learning (pedagogy), research experience and perception, and culture.

INGREDIENTS

The main theoretical and conceptual ingredients for this BIG work were: Student-Driven Learning, SDrL (in this study the term 'Self-Driven Learning' was used), Threshold Concepts (TC), conceptual thinking, and Students as Partners, SaP.

- SDrL concerns the transfer of power and initiative to students, to enhance their learning.
- TC was developed by Meyer & Land some 15 years ago. TC allows to focus on barriers and carriers for learning complex concepts – in this study these complex concepts are research methods. A TC requires expert knowledge – of a teacher – to be made explicit and broken down into manageable pieces for student learning.
- In this study, a method called 'Cognitive Task Analysis' was used by students.
- Conceptual thinking is a higher-order thinking approach that enables students to learn aggregates of smaller concepts – in this study this also relates to research methods.
- SaP is a fairly novel concept concerning partnering of teachers and students – in this study: on educational research.

RESEARCH DESIGN

Sandor and Hans used a quasi-experimental design, by comparing the experimental sub group's results.

They used instruments several instruments: (1) a tailor-made self-report entrance survey for students to rate five competences (conceptual thinking, English language reading speed and understanding, experience with and perception of scientific research, transfer from one context to another). (2) PARI (Precursor, Action, Result, Interpretation), which is a specific form of Cognitive Task Analysis (CTA) used by the students as well as by the researchers to organize their thinking and learning of social sciences research, and for the researchers to learn about the students' problems and progress. (3) A tailor-made rubric to evaluate students' cognitive understanding of academic research. (4) A post-intervention survey, also tailor-made.

Researchers obtained BMS' Ethics Committee approval for this study.

HYPOTHESES

1. Self-Driven Learning is a Threshold Concept for students
2. Learning to be a researcher is a Threshold Concept for students
3. CTA (PARI) is suitable for the identification of Threshold Concepts
4. CTA (PARI), used by students, is an effective instrument for learning (e.g. in Conceptual Thinking and planning skills)
5. The premaster course has elements supporting its effectiveness, and elements that hinder its effectiveness
   (identifying the elements that hinder effectiveness opens up possibilities for course improvements)
6. Intrinsic motivation is a vital element of study success in the premaster course (e.g. Reeve, 2012)

DELIVERY

Premaster (1 EC)

Pre-class study materials include video lectures and book chapters of Cooper & Schindler, *Business Research Methods*.

A series of eight 2-hour sessions was organised, e.g. an Introduction - on academic research and the Managerial Problem Solving Method; a series of sessions on Essay Assignment, learning goal, action plan and Cognitive Task Analysis (see below); Research plan; Data preparation, collection and analysis; Deriving conclusions and academic writing.

The assessment of this 1 EC part consisted of:

- Individual essay (10% weight)
- Individual exam (10% weight)

Note: the 4 EC course part in Q2 has the remaining 80% weight

The essay assignment is a small, individual assignment intended as an induction in academic research. A student needs to choose and to define a learning goal regarding academic research eg 'what is validity?'. During this assignment, the student uses Cognitive Task Analysis, CTA, to identify tasks and their complexity. The student adds the final CTA to the essay for assessment.

CONCEPTUAL UNDERSTANDING

Based on a dedicated literature search, Sandor and Hans developed an initial rubric for conceptual understanding.

From this initial rubric, they made a measurement rubric using 5 stages (off-track; novice; apprentice; practitioner; expert).

To each of the 5 stages identifying key words were added, like the ones in Bloom's taxonomy. (Please see the reference list.)

Sandor used this measurement instrument to determine Cognitive Understanding Score (CUS). Cognitive Understanding Progress (CUP) was calculated as the difference between end and start, i.e. CUS(end) minus CUS(start)

RESULTS

The results of this study are summarized in four distinct areas:

1. From the survey results, indications of two types of Threshold Concepts (TCs) were found. One TC is about research methodology learning. The other TC is about pedagogy, i.e. Self-Driven Learning. An example of survey results (entrance) is in *Figure 2*, topline on conceptual thinking.

2. By X,Y plotting of the Essay grades with the Cognitive Understanding Scores (CUS), and adding Cognitive Understanding Progress (CUP) data, five sub-groups of students were identified. After some further aggregation of the plotted data, to enhance statistical power, the t-testing ($p<0.10$) results were used to propose that differences in part are related to students' perceptions of the course's pedagogy; this confirms point 1. *(Figures 4 and 5)*

3. Cognitive Task Analysis (CTA, PARI) results were analysed to identify any differences between students scoring High CUP or Low CUP. We found support for CTA being supportive to learning. First, per-student totals of CTA counts by high CUP students were twice as high compared to low CUP students. Second, the 'Practitioner level' as a whole scored over 2 times higher (per student) for the high CUP students. Third, 'Apply Theory to Practice' had 5.5 more counts per student for high CUP than for low CUP students. On several other parameters, high CUP students scored higher than low CUP students. It was considered likely that certain students are able to identify more complex tasks (CTA) and can learn from using CTA as well. *(Figure 4)*

4. Essay grades were found to be promising. *(Figure 3)*

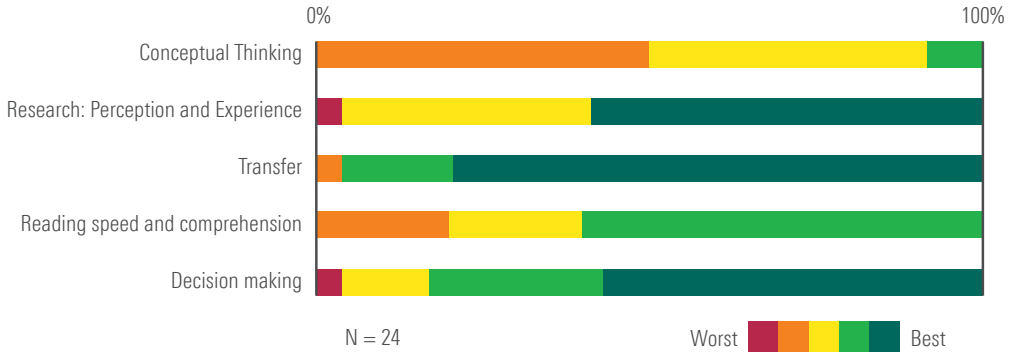

Figure 2. Premaster entrance (base line measurement) survey aggregate results 2017

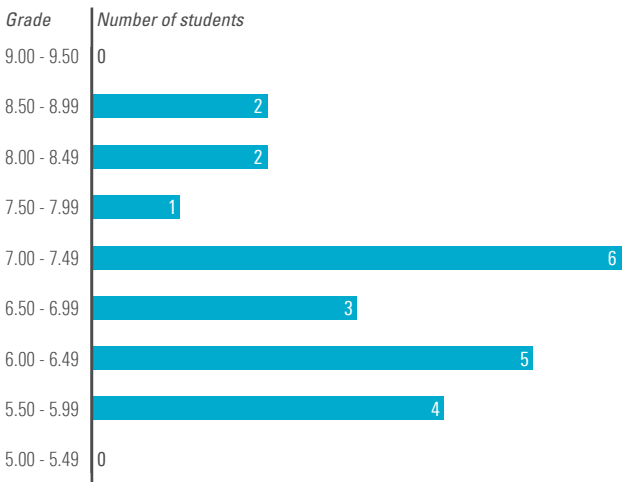

Figure 3. Essay grade distribution - premaster

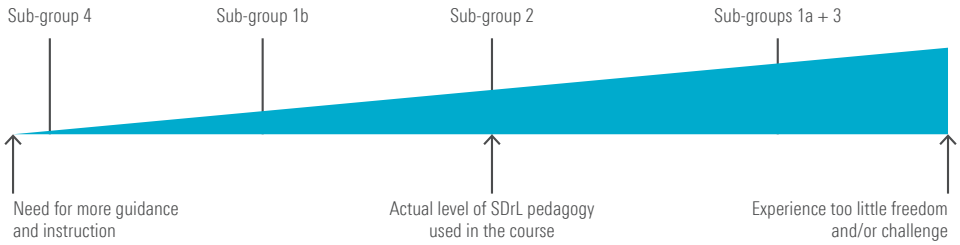

Figure 4. Student-driven learning maturity continuum

Figure 4 presents a tentative picture of the subgroups positions on an SDrL continuum. The blue triangle shows a continuous increase in the level of Student-driven Learning. For Sub-group 2 the chosen pedagogy seems to be optimal. Our conclusion is that we need to continue our efforts to break down the TC of SDrL (and research methodology) to allow better learning by all subgroups.

Figure 5. Conceptual Understanding Score (CUS) v.s. Essay Grade

SIX RESEARCH HYPOTHESES

CONFIRMED 1. Self-Driven Learning is a Threshold Concept for students
CONFIRMED 2. Learning to be a researcher is a Threshold Concept for students
CONFIRMED 3. CTA (PARI) is suitable for the identification of Threshold Concepts
PARTLY 4. CTA (PARI), used by students, is an effective instrument for learning (e.g. in Conceptual Thinking and planning skills)
CONFIRMED 5. The premaster course (or Module 11) has elements supporting its effectiveness, and elements that hinder its effectiveness (identifying the elements that hinder effectiveness opens up possibilities for course improvements)
INDIRECTLY 6. Intrinsic motivation is a vital element of study success in the premaster course and Module 11 (e.g. Reeve, 2012)

Sandor and Hans have studied a large body of literature for this study, and for previous work. Please contact CELT, the Centre of Expertise in Learning & Teaching, for more details. The reference list presented below contains a conference paper on this study, and some selected references.

CONCLUSIONS BASED ON THIS WORK

1. Cognitive Task Analysis can be used to identify Threshold Concepts : 'reading students' minds'
2. Conceptual understanding is not sufficient – ability to apply concepts is required
3. Pedagogical method (SDrL) can be a threshold concept as well
4. Even in small groups there are quite some differences, presenting a pedagogical challenge

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Entrance survey sources
E.g. reading speed and comprehension test: http://www.readingsoft.com/quiz.html

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COLOPHON

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