Teaching and learning of interdisciplinary thinking in higher education in engineering
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The present thesis research aim was to gain insight in the pedagogical content knowledge for interdisciplinary thinking to enhance student learning across higher education in engineering. In accordance to Boix Mansilla (2010) and Shulman (1987), pedagogical content knowledge was considered in the present research as an understanding of the unique teaching and learning demands to ensure quality student learning processes. To achieve the aim of gaining insight in these teaching and learning demands, the understanding of design criteria of interdisciplinary learning environments (*teaching-focus*) and the understanding of interdisciplinary learning process characteristics (*learning-focus*) were considered as necessary.

Four studies were conducted to investigate the teaching and learning demands that need to be taken into account in order to teach engineering students interdisciplinary thinking with respect to complex problem solving. The first and second studies mainly focused on the *teaching* using the constructive alignment theory of Biggs and Tang (2011). The first study was a systematic literature review study that has identified five necessary sub-skills of interdisciplinary thinking and 26 typical conditions for enabling the development of interdisciplinary thinking. The second study was a design-based research study in which the identified sub-skills and conditions were used to redesign an existing interdisciplinary course in food quality management. The design-focused evaluation showed that eight design criteria need to be taken into account to improve the quality of interdisciplinary learning environments.

The third and fourth studies mainly focused on student *learning* of the redesigned course on food quality management, using the learning theory of Illeris (2003). The third study analytically characterized student learning experiences and showed that these experiences can be divided into the content, incentive, and interaction dimensions, and that for each dimension key experiences could be identified. The fourth study analysed student learning in terms of learning challenges, strategies, and outcomes. With respect to the challenges, the results showed that students tend to report more on the content-related and interaction-related challenges than on the incentive-related challenges. Both conducted analyses provided insights on learning process characteristics that need to be taken into account to improve the quality of student interdisciplinary learning.

The major conclusions of the present thesis research is that the identified teaching and learning demands involve an initial basis of the pedagogical content knowledge for interdisciplinary thinking, which needs validation across higher education in engineering. In addition, the present thesis research concludes that the constructive alignment theory of Biggs and Tang and the learning theory of Illeris are indeed suitable to develop pedagogical content knowledge for a particular complex cognitive skill such as IDT. Furthermore, the present research concludes that the research methodology of design-based research is beneficial to jointly investigate design criteria and learning process characteristics.

References

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