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ASSESSMENT OF CONCEPT MAPS AS REPRESENTATIONS OF COMPLEX KNOWLEDGE AND ITS USE FOR TEACHING–LEARNING-PROCESSES

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Abstract. Concept maps (Novak & Cañas, 2006) seem to be a suitable measure for reconstructing complex knowledge as relational systems. Concept maps correspond with the notion of knowledge as semantic network (e. g. Dansereau et al., 1979). In order to assess concept maps several (scoring) techniques have been used, among them the number, existence or accuracy of concepts and/or propositions, or the overlaps of individual concept maps with a criterion map (Falmagne & Doignon, 1988; Ruiz-Primo & Shavelson, 1996; Ifenthaler, 2006; Cathcart et al., 2010). However, often neither quantitative nor qualitative results can be directly used for instruction. Thus, the work already done can be complemented by using models and measures strongly combining qualitative and quantitative research tradition. The results will allow defining more content valid and concrete starting points for effectively improving teaching-learning processes.

We will exemplify this approach using data about novices' conceptions of successfully starting up a business. 29 students of engineering sciences took part in the study. We aimed at identifying congruencies and differences between all individual maps and a criterion map, here an experts' map of the contents. The criterion map was assessed with regard to its internal consistency as measure of representativeness. For that, we transformed all concept maps into a person x proposition matrix. For every test person the variable proposition was coded “1” in case the test person used it or “0” (dummy) in case the test person did not use it. This allows us to use measures of multivariate statistics and classical test theory for analyzing the data.

The congruency of individual maps and criterion map results in a scale for which we can calculate the internal consistency (reliability). The coherence of every single proposition with this scale can be assessed by its item total correlation (discriminatory power). Based on a discriminatory analysis the internal consistency of the criterion map can be increased by simultaneously controlling its representativeness. The internal consistency (reliability) is indicated by Cronbach’s Alpha (α) which should range from 0 to 1. To calculate the item total correlation we correlate every 0/1 variable (for all maps) with the number of congruent propositions of individual map and criterion map. If the correlation is > 0, the proposition fits the criterion map and vice versa. To determine whether the item total correlation is significant, we defined a 10% probability level. Consequently, propositions in the criterion map showing a negative item total correlation have to be excluded in order to increase the internal consistency. Propositions with a significant positive item total correlation can be included in the criterion map. Based on the value of the item total correlation of the propositions we can exactly identify contents to be further discussed in the instruction process, and contents not to be considered in classroom.

References

Novak, J. D. & Cañas, A. J. (2006). The Theory Underlying Concept Maps and How to Construct Them. *Technical Report IHMC CmapTools 2006-01*, Florida Institute for Human and Machine Cognition.

Cathcart, L., Stieff, M., Marbach-Ad, G., Smith, A., & Frauwirth, K. (2010). How to Use Knowledge Space Theory to Analyze Concept Maps. *Proceedings International Conference of the Learning Sciences*, Vol. 1, 966-973.

Dansereau, D. F., Collins, K. W., McDonald, B. A., Holley, C. D., Garland, J. C., Diekhoff, G., & Evans, S. H. (1979). Development and evaluation of a learning strategy program. *Journal of Educational Psychology, 71*, 64-73.

Falmagne, J, & Doignon, J. (1988). A Markovian Procedure for assessing the state of a system. Journal of Mathematical Psychology, 32, 232-258.

Ifenthaler, D. (2006). *Diagnose lernabhängiger Veränderung mentaler Modelle. Entwicklung der SMD-Technologie als methodologisches Verfahren zur relationalen, strukturellen und semantischen Analyse individueller Modellkonstruktionen*. Freiburg: FreiDok.

Ruiz-Primo, M. A., & Shavelson, R. J. (1996). Problems and Issues in the Use of Concept Maps in Science Assessment. Journal of Research in Science Teaching, 33(6), 569-600.

Novak, J. D. (1998). Learning, creating, and using knowledge: Concept Maps as Facilitative Tools in Schools and Corporations. Mahweh, NJ: Lawrence Erlbaum Associates.

Novak, J. D., & Gowin, D. B. (1984). Learning How to Learn. New York: Cambridge University Press.