Network Analysis Of Changes To An Integrated Science Course Curriculum Over Time

*Curriculum texts for science courses change over time as policy changes. Changes occur in particular wordings in official documents and give rise to changing possible interpretations. Using a recently published method of analysis, this study constructs thematic maps of the development of the curriculum for the upper secondary Danish "Basic Science Course". The analysis integrates qualitative analysis (critical discourse analysis) with quantitative analysis (linguistic network analysis) to identify and characterise themes in official curriculum texts for the course. This is done for years 2004 (first curriculum text), 2007 (first change), and 2010 (second change). This paper focuses on three themes, which were identified as part of the anlaysis: Structural Demands, Implementation of Teaching, and The Importance of Science in a Bildung Perspective. The findings show that Structural Demands change little over time; the didactical focus remains on "active learning". However, interdisciplinarity is part of this theme and is framed differently each of the years of change; from being an intention in 2004 to being "normal" in 2007 to being taken for granted in 2010. Implementation of Teaching first appears as a theme in 2007 and matures in 2010 to be linked to the identity of the course as well as the goals for competences to be learned. Finally, we find that The Importance of Science in a Bildung Perspective starts out as a separate theme but merges in 2010 to become integral to the purpose of the Basic Science Course. This may signify a maturation of the course to represent a discipline in its own right. It may also imply an official intention that science should be part of most students' development as citizens. The paper discusses how these curricular analyses can be linked to the political discussions amongst stakeholders and to recent programme evaluations of the Basic Science Course.*

*Keywords*: Curriculum, Nature of Science, Interdisciplinarity

Context and relevance to science education

Official educational documents often reflect an agglomeration of political intentions at a given time and may change in light of educational policies change (Dolin & Evans 2018). Educational policies vary along many dimensions across national contexts (Evans et al 2018). The wording of particular curriculums can influence the perceived possibilities for teachers in implementing new curriculums (Evans & Dolin 2018). Analysing themes that emerge in official documents may play an important role in understanding the interplay between intentions, implementation and realisation of teaching (Akker, Fasoglio, and Mulder 2010). This paper aims at utilizing a recently developed methodology for analysing texts to find, characterise, and interpret themes in official curriculum texts as they develop over time.

Rationale and grounding

In many countries, ideas of inquiry and scientific literacy have been woven into national curriculums (Dolin & Evans 2018). In Denmark, ideas of inquiry and SL (and also interdisciplinarity and Bildung) were implemented officially in the largest of the four national upper secondary programs (called *stx*) in 2004. This was done through the introduction of the Basic Science Course (BSC, “Aftale af 28. maj” 2003). The curriculum text was changed in 2007 and 2010. The course has also been debated and evaluated (e.g. Dolin, Jakobsen, Jensen & Johannsen 2014). Thus, it was expected to work well as an example of curriculum text change. The complexity of educational systems (Evans et al 2018) can be seen to warrant an integration of quantitative and qualitative perspectives into a mixed methods design (Roberts & Onwuegbuzie 2004). This also holds for analysis of educational policy. This study uses a recently developed mixed methods methodology (Authors 2018b) to extract and interpret themes in curriculum texts and their interconnections. The research questions are: Which interconnected themes emerge as prevalent as in the Danish BSC curriculum texts for years 2004, 2007, and 2010? How do selected themes evolve through years 2004, 2007, and 2010?

research method

The method of analysis relies on a combination of discourse analysis and linguistic networks (here networks, where words in the curriculum text are connected to each other based on adjacency). Linguistic networks (e.g. Mehler, Lücking, Banisch, Blanchard, & Job 2016) have previously been used in science education to create maps of national statements regarding scientific literacy (Authors 2009, Dolin & Evans 2018). Authors (2018) recently combined qualitative discourse analysis with linguistic networks in a mixed methodology for transcripts of group discussions. The analysis revealed and graphically displayed hidden themes to provide a nuanced and rich picture of the data. The method starts from a discourse analysis of the text and rigorously proceeds to transform text into linguistic networks. Using a reliable clustering algorithm (Bohlin, Edler, Lancichinetti, & Rosvall 2014) networks are then converted into maps of interconnected structural themes, which are interpreted in light of the discourse analysis. The end product is a thematic map of interconnected themes, each with their own interpretation and internal structure of words (see Figure 1).

Findings

This study revealed 13 different themes across the three years. Each theme is constituted by a number of connected words. Table 1 summarises four of the most prevalent and central themes.

Table 1. Themes identified in thematic maps. Themes with higher numbers are often more prevalent.

|  |  |  |
| --- | --- | --- |
| **#** | **Theme** | **Summary of interpretations (quotes are our translations)** |
| 10 | Structural demands to the BSC | Focus on student activity, thematic topics and pluridisciplinarity. Sample wording belong to this theme (2004): *"the BSC implementation should be based on thematic topics which are preferably pluridisciplinary"* |
| 11 | Importance of Science in a Bildung perspective | Focus on the developing students as persons who can reflect on science as they take part in society. Sample wording belong to this theme (2004/2007/2010): “*[students] can express a knowledge-based opinion on issues and problems with a natural sciences aspect.”* |
| 12 | Implementation of teaching | Requirements for implementation. The theme appears in 2007 and 2010. Sample wording (2010): *”[…] observations should be integrated into teaching and choice of themes should make possible [student] completion of experiments”.* |
| 13 | BSC identity as a course | Constitutes the BSC as a subject, which introduces the natural sciences and scientific methods. Sample wording belonging to this theme (2007): *"introduction to natural science (...) through working with the basic elements of natural science with emphasis on the coherences in natural science."* |

Here, we highlight three findings: (1) Over the three iterations, Theme 11 becomes more and more connected to Theme 13. See Figure 1. In 2007 there are thick connections between the two themes (indicating that phrases and wordings in one theme are connected extensively to phrases and wordings in the other) and in 2010, they are merged into one, because they can no longer be separated. This may indicate that the intentions for the BSC develop from an agglomeration of different disciplines to a discipline in its own right. (2) As seen in Table 1, Structural Demands mentions pluridisciplinarity (Jantzch 1972). The framing of pluridisciplinarity changes over time: From teaching topics being “*preferably pluridisciplinary”* (2004)*,* to being “*normally pluridisciplinary” (2007)* to being *“thematic plurisciplinary topics”* (2010). This can be seen as a move from pluridisciplinarity as a suggestion to becoming the norm to becoming taken for granted. (3) Implementation of Teaching occurs first in 2007 gets clearer connections to Practical Work, Competences to be Learned, and Theme 11+13 in 2010. The theme contains national instructions to how teaching should be implemented. This is significant to a Danish system which relies heavily on teacher autonomy (Evans et al 2018)

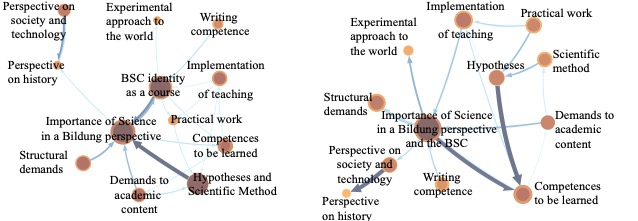


Figure 1. The thematic map for the BSC curriculum from 2007 and 2010. The BSC curriculums are each divided into 12 themes. The sizes of circles signify the prevalence of the theme as measured by the accumulated PageRank of the constituent words in themes.

Discussion and Implications

This study has potential implications for our understanding of the interplay between curriculum texts, practice, and political trends. For instance, one could ask if the merger between Themes 11 and 13 in 2010 aligns with public discussions about the relationship between Bildung and Science in preceding years. In terms of practice, an investigation of teachers’ perception of the purpose of the BSC aligns well with the merger between Themes 11 and 13; the BSC is often seen as a Bildung course with emphasis on interdisciplinarity (Dolin et al 2014). Note that there are several methodological considerations to be discussed, for example, whether the thematic maps of this paper are good representations of how the curriculum texts are intended by official bodies and how they are interpreted by teachers. This will be addressed in the final paper.

REFERENCES

Aftale af 28. maj 2003 mellem Regeringen […] om reform af de gymnasiale uddannelser. (2003). Retrieved January 31st 2019 from: <http://www.gl.org/uddannelse/udd.politik/Documents/Politisk%20aftale%20-%20reform.doc>

Akker, J. van den, D. Fasoglio, and H. Mulder (2010). A curriculum perspective on plurilingual education. Online resources by the Council of Europe. http://www.oerp.ir/sites/default/files/parvande/SLO\_persp2010\_EN.pdf.

Authors (2009)

Authors (2018)

Bohlin, L., Edler, D., Lancichinetti, A., & Rosvall, M. (2014). Community detection and visualization of networks with the map equation framework. In *Measuring Scholarly Impact* (pp. 3-34). Springer.

Dolin, J., & Evans, R. H. (red.) (2018). *Transforming assessment: through an interplay between practice, research and policy*. Springer. Contributions from Science Education Research, Bind. 4 <https://doi.org/10.1007/978-3-319-63248-3>

Dolin, J., Jacobsen, L. B., Jensen, S. B., & Johannsen, B. F. (2014). *Evaluering af naturvidenskabelig almendannelse i stx-og hf-uddannelserne*. Dpt. Of Science Education, University of Copenhagen.

Evans, R. H., Cross, D., Grangeat, M., Lima, L., Nakhili, N., Rached, E., ... Ronnebeck, S. (2018). European Educational Systems and Assessment Practice. I J. Dolin, & R. Evans (red.), *Transforming assessment: Through an interplay between practice, research and policy* (s. 211-226). Springer.

Evans, R. H., & Dolin, J. (2018). Taking Advantage of the Synergy Between Scientific Literacy Goals, Inquiry-Based Methods and Self-Efficacy to Change Science Teaching. I . Tsivitanidou, P. gray, E. Rybska, L. Louca, & C. Constantinou (red.), *Professional Development for Inquiry-Based Science Teaching and Learning* (pp105-120). Springer.

Jantsch, E. (1972). Inter- and transdisciplinary university: A systems approach to education and innovation. *Higher Education Quarterly 1*(1), 7–37. issn: 1468-2273. doi: 10.1007/BF01956879.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher*, *33*(7), 14-26.

Mehler, A., Lücking, A., Banisch, S., Blanchard, P., & Job, B. (Eds.). (2016). *Towards a theoretical framework for analyzing complex linguistic networks*. Springer.