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The Impact of Interdisciplinary STEM Innovation on the Role Identity of Science Teachers

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Abstract: The promotion of K-12 STEM education creates new conditions for science teachers to learn new elements in practice. This learning experience would affect teacher role identity development and hence the subsequent innovation process. This study explores how the innovation of STEM education influences the role identity development of science teachers with a focus on how various aspects of practice that teachers experienced in their school contexts impact on their role identity development.

Keywords: Role identity, interdisciplinary STEM, epistemic network analysis

Theoretical perspectives

Teachers learn and negotiate their identities through experience (Sachs, 2005) that teacher role identity is not static but developmental, subject to change in new conditions. Identity change can be regarded as a teacher learning outcome (Garner & Kaplan 2019). The change of teacher role identity affects how teachers engage in the innovation process and where they want to be as well as the scalability of an innovation (Chee, et al., 2015). Integrating both sociocultural and psychological perspectives in conceptualizing teacher identity, the Dynamic Systems Model of Role Identity (DSMRI) acknowledges the influence of school contexts, culture as well as personal disposition and emotion in teacher role identity development (Garner & Kaplan 2019). Extant literature informs us that teacher role identity might be developed in different dimensions such as leadership and pedagogy, depending on their practice experience. We have a question about how teacher learning in practice in STEM innovation affects their role identity development. This question relates to how teachers position themselves in the innovation and their capacity of taking up and scaling up innovation. This study explores the role identity development of four science teachers' after a year of STEM innovation, drawing on the four major components in the DSMRI model: (1) ontological and epistemological beliefs *("Belief" in Figure 1)*; (2) purpose and goals *(Goal)*; (3) self-perceptions and self-definitions *(Self)*; (4) perceived actions possibilities *(Possibility)* (Garner & Kaplan 2019). The following two research questions guide this study:
(1) What changes in the development of role identity among the four teachers in a year?
(2) How do their changes in role identity relate to their practice experience of STEM innovation?

Method

We used the first-year data from a 19-month government-funded University-school partnership programme which supported project network schools to design school-based STEM curriculum topics with self-directed learning pedagogy (Hew, et al., 2016). Four science teachers, Nick, Lily, Craig and Roy from four different schools in the network were selected for this multiple-case study. All STEM topics they implemented adopted self-directed learning pedagogy and required students to integrate learning elements from two or more disciplines.

We examined individual school conditions for teacher learning through innovation with data generated from pre-post teacher and principal interviews, co-planning and debriefing sessions, and school reports prepared by the University research team. We analyzed how various aspects of practice influenced different teacher role identity components with transcriptions of the pre-post teacher interviews in which there were questions letting teachers elicit their identity aspects and experience of practice. Extracted content for each identity component was examined and categorized in terms of their developmental dimensions. An emerging identity component of "challenges" was added in DSMRI for indicating perceived hindrances or difficulties. Five dimensions for identity development in STEM innovation were identified: (a) *pedagogy ("PG" in Figure 1)*, (b) *discipline (DS)*, (c) *interdiscipline (InterD)*, (d) *professional development (PD)*, and (e) *leadership (LD)*.

The five identity components and the five dimensions formed ten categories for coding for the epistemic network analysis (ENA, Shaffer, et al., 2016). The pre and post interviews formed the two timeframes for comparison (Figure 1). The interpretation was done together with the earlier analysis on individual schools' conditions for teacher learning through STEM innovation.

Findings and conclusion

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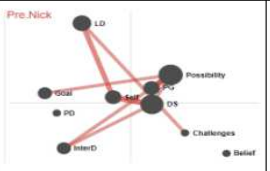
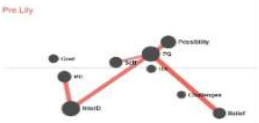
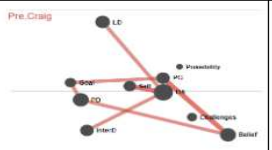
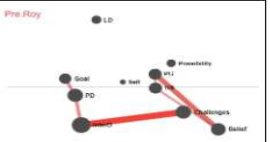
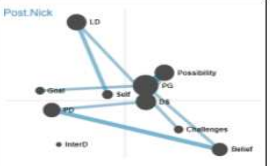
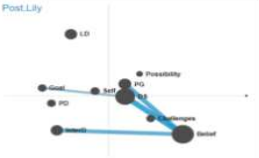
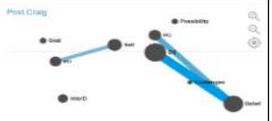
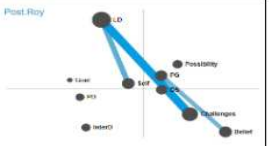
	Nick	Lily	Craig	Roy
Pre timeframe				
Post timeframe				
School Team	Cross-subject Science team	Cross-disciplinary team	Cross-disciplinary team	Cross-subject Science team
Specific School contexts	-Nick held responsible to report to the Principal and the academic department about the STEM innovation -The team decided to experience co-teaching in the process	-Lily focused on science learning with the technology teacher supported the making part -The principal and the technology teacher led the STEM innovation	-Craig worked on his own in science classroom only -The vice-principal in the team was the STEM leader not Craig and gave administrative support to Craig when needed	-Roy held responsible to report to the Principal and the academic department about the STEM innovation -Roy was newly appointed as a leader of Science and Technology

Figure 1. The comparison plot for the four teachers, from left to right Nick, Lily, Craig and Roy

The change in the strength of connection between the dimensions for identity development *(PG, DS, InterD, PD, LD)* and role identity components *(Goal, Belief, Self, Possibility, Challenge)* gives indication for their role identity development after a year (Figure 1). In terms of leadership dimension, Lily and Craig did not show any significant development, while Nick maintained and Roy grew stronger. Unlike Lily and Craig, Nick and Roy experienced more interaction mechanisms of monitoring and reporting. Only Lily showed connection between the interdisciplinary dimension (*InterD*) with a role identity component (belief). Her implementation experience in the cross-disciplinary team let her see that interdisciplinary collaboration could satisfy her interest in science learning. It seems the development on disciplinary dimension grows stronger in a cross-disciplinary team.

This study contributes to exploring teacher learning as role identity change in the context of STEM innovation. There are multiple dimensions for teacher development in STEM innovation. The focus on a single dimension such as pedagogy might not be enough to enhance teacher capacity if they need to steer STEM innovation at school. Further research on more cases are needed for seeking the understanding of how certain patterns of school conditions affect identity development and the scalability of innovation.

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