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Paper Title  Collaboratively Learning How to Use Data: The Process of Knowledge Creation

Author(s)  Mireille Hubers, University of Twente; Cindy Louise Poortman, University of Twente; Adam Handelzalts, Universiteit Twente; Kim Schildkamp, Universiteit Twente; Jules M. Pieters, Universiteit Twente

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Collaboratively Learning How to Use Data: The Process of Knowledge Creation

Objectives
Data-based decision making in education has become increasingly important, as it can lead to school improvement in terms of increased student achievement (Datnow, Park, Kennedy-Lewis, 2013; McNaughton, Lai & Hsiao, 2012). However, teachers often do not use data effectively (Authors, 2010): a majority of their decisions is based on intuition and limited observations (Ingram, Louis & Schroeder, 2004). The data team procedure was implemented in secondary education in the Netherlands to support teachers and school leaders in the use of data (Authors, 2014).

When working with the data team procedure, several activities have to be undertaken to use data (Authors, 2014). First, the purpose of data use needs to be determined. Second, data are collected and turned into information through analyses. Finally, this information is integrated with one’s own understanding and expertise, thereby transforming it into knowledge. To further support effective use of data in education, more insight into this process of knowledge creation is essential (Little, 2012). Therefore, the following research question is posed: How do teachers and school leaders create knowledge within and between data team meetings?

Theoretical Framework
A data team consists of approximately six teachers and school leaders, who meet twice a month for two years (Authors, 2012). During these meetings, they work with an eight-step systematic and cyclic procedure, which is illustrated in Figure 1. The procedure includes an extensive set of guidelines and activities, and a trainer from the university provides them with support. The goal of the data team procedure is to educate teachers and school leaders in how to use data in their decision-making. In addition, they learn how they might solve an educational problem they are facing, such as low student achievement. This improves the quality of their education (Authors, 2012). In this procedure, data are defined as ‘Information that is systematically collected and organized to represent some aspect of schools’ (Authors, 2013). This broad definition encompasses both quantitative data, such as assessment or questionnaire data, and qualitative data, such as interview or observation data.

Many theories on knowledge creation exist (e.g. Bereiter, 2002; Engeström, 1999; Knorr-Cetina, 1981; Szulanski, 1996; Wenger, 1998). Nonaka and Takeuchi’s model of knowledge creation (1995) is used in the present study because its main premise is that knowledge creation: ‘depends on tapping the tacit and often highly subjective insights, intuitions, and hunches of individual employees and making those insights available for testing and use by the company as a whole (Nonaka, 1991, p.97)’. This relates to the data team procedure as one of the main starting points of working in a data team is that teachers and school leaders bring forward their insights, intuitions and hunches about their education to formulate an hypothesis (step 2), which is made available for testing (step 3-5). When conclusions are drawn (step 6) it is possible that these insights are invalidated, which can be a real eye-opener (Authors, 2012). In the present study, it is assumed that this is a powerful learning mechanism that enhances knowledge creation.
Within Nonaka and Takeuchi’s Socialization, Externalization, Combination, Internalization (SECI) model, knowledge is distinguished on a continuum ranging from explicit to tacit (Nonaka, 1991). Explicit knowledge can be uttered and captured in writing, whereas tacit knowledge is tied to senses and intuition. Both explicit and tacit knowledge are not substances you have, but are a process of (dis)confirming your beliefs based on your interactions with the environment (Nonaka, Toyama & Hirata, 2008). In this process, tacit and explicit knowledge interact with each other, which results in newly created knowledge (Nonaka, 1991).

The SECI model is composed of four modes and reflects a dynamic process, which means that the modes are addressed in a non-linear manner (Nonaka et al., 2008). Therefore, knowledge creation can be seen as a continuous flow across modes, in which each mode provides a ‘snapshot’ of the process:

- Socialization: tacit knowledge is shared, for example through telling about one’s own experiences and observing experts. Applied to the context of the data teams, this could for example entail that the data team members discuss what they think could have caused the problem they are working on (e.g. low motivation of students), and provide each other with background information.

Figure 1. The data team procedure (Authors, 2012, p56.).
• Externalization: tacit knowledge from the socialization stage is made explicit through models, language, images and other modes of expression. The data team members could for example define what they consider to be ‘too high’ retention rates.

• Combination: group members collect explicit knowledge and define and edit it into a more complex and systematic set of knowledge. It can also include breaking down concepts, for example by translating an educational vision into a concrete educational concept. In this stage, the data team members could, for example, decide to check whether their survey data leads to the same conclusions as their interview data.

• Internalization: the created knowledge is put into practice. This mode also includes critical reflection and results in a knowledge base for new routines. For example, some data teams conduct statistical analyses with the sole purpose of practicing their skills.

Research on how individuals or groups move through the SECI modes is scarce. For example, Yeh, Huang and Yeh (2011) found that their teacher training program based on the SECI modes significantly improved teachers’ professional knowledge. However, it remains unclear whether the teachers go through the different modes in a specific pattern. It might be that individuals automatically go through the modes in a similar matter. For example, you cannot reflect on your knowledge when you are not even aware of it, so it is unlikely that individuals work in the internalization mode before they have worked in the socialization mode. However, when individuals do not engage in these modes in a similar fashion, it might be that one way is more effective than the other. Thus, the effectiveness of a data team might depend on the team’s pattern of knowledge creation. This requires a better understanding of the SECI modes. In the present study, three elements were hypothesized to be of importance when studying this model of knowledge creation.

The first element is the *state* of the mode as such, for example working in the socialization mode. The second element is the *transition* between the modes, for example moving from the socialization mode to the externalization mode. The third element is the *content*. Central subject matters when working with the data team procedure are the educational problem that is being studied, knowledge on data use on the educational problem, and knowledge on data use in general. It might be that these subject matters are predominantly discussed in certain modes. For example, discussing the educational problem might be of particular importance when the data team members are uncovering their personal beliefs and theories on the cause of the problem in the socialization mode. These elements will be studied to capture the process of knowledge creation both within and between data team meetings.

**Methods, Techniques and Data Sources**

The datateam procedure was implemented at ten schools for secondary education for a two-year period. A case study was conducted at two schools, Lincoln and Fairview\(^1\), who worked on the same educational problem (too much grade retention) and had comparable levels of data use at the beginning of the project.

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\(^1\) To guarantee anonymity of the participants, school names have been changed.
A coding scheme was developed as presented in Table 1, which was inspired by previous research on the SECI modes (e.g. Tee & Karney, 2010). All data team meetings over the course of the two-year professional development trajectory, 21 meetings for Lincoln and 24 meetings for Fairview, were audio-taped by the trainer, and transcribed and coded in Atlas.ti by the researchers. The coding scheme encompassed combinations of the SECI modes and the knowledge content. Thus, the mode and the content of the mode had to be indicated per segment. An example of this is: socialization – educational problem.

To determine the inter-rater reliability, 10% of the meetings (5 out of 45) were coded by the second author. This resulted in an inter-rater reliability of .60, which is considered acceptable (Eggen & Sanders, 1993).

A thick description (Geertz, 1971) of the team’s knowledge creation process was made per meeting. This description included all three elements of the process: the state of the mode, the transition between modes, and the content that was discussed in the states and in the transitions. Furthermore, the alterations between codes were visually represented in a graph. In addition, log files written by the trainer, who supervised both data teams, and teams’ status reports were analyzed to describe the data teams’ progress.

**Results and Conclusions**

The results showed that the knowledge creation process changed over the course of the data team meetings. For example, during the first meetings of Fairview’s data team, the members were predominantly working in the socialization mode (e.g. brainstorming). However, over time, they increasingly engaged in the other modes. For example, from the fifth meeting onwards they also occasionally worked in the internalization mode (e.g. by reflecting on their work).

It appeared that transitions were often caused by the structure of the data team procedure. For example, the procedure requires a concrete testable hypothesis at the end of step 2 (see Figure 1), which should be written down in the minutes. This requirement ensured that data team members checked whether their hypothesis met the criteria and was written down. Because of that, the members started working in the externalization mode. An example of this is:

[A discussion on possible hypotheses is taking place]

> ‘So, our problem is that our students do not obtain the level that could be expected. That could be a possible hypothesis, or, first, a problem statement?’

< ‘Shall I write this down? [...] Our students of the lower grades do not obtain the educational level that could be expected.’

Furthermore, the content changed over time. The data team members predominantly talked about the educational problem in the first meetings. An example of this is: ‘One of the problems at our school is that students do not know what to expect’. Subsequently, they increased their conversations on data use in general. For example, ‘We have this new ICT tool that can get all kinds of data out of our system.’ In the paper, the results will be described more extensively.
<table>
<thead>
<tr>
<th>Mode</th>
<th>Definition</th>
<th>Educational problem</th>
<th>Data use on problem</th>
<th>Data use in general</th>
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<tr>
<td>Socialisation</td>
<td>Data team members aim to understand each other’s ideas, conceptions and prejudices, and explore the possibilities. They discuss, explore or share mental models, or provide each other with background information on the school.</td>
<td>‘I believe some primary schools do not do their job properly. Students from these schools fall behind in my course.’</td>
<td>‘When your school is in this area [referring to a graph], it has an average score.’</td>
<td>‘We have a new tool that can automatically do these analyses.’</td>
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<td>Externalisation</td>
<td>Data team members prepare or perform activities such as collecting information, observing, using surveys or contemplating experts. They define terms, concepts and meanings.</td>
<td>‘Let’s ask the principal why students cannot repeat a grade.’ ‘So, we are satisfied when we achieve…’</td>
<td>‘Here, you see that 60% is below the desired level.’ ‘The Inspectorate calculates grade retention like this.’</td>
<td>‘You cannot just drop students from your data file, you have to have a reason to do so.’ ‘A t-test is…’</td>
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<td>Combination</td>
<td>Data team members draw conclusions, and the resulting knowledge has the potential to be shared immediately with colleagues. This includes accepting or rejecting hypotheses. They translate knowledge into concrete products, solutions or policies. They use logic is to solve contradictions.</td>
<td>‘In the literature it is stated that…’ ‘Our pupils say we have to be more strict. So, the teachers have to check their homework each lesson.’ ‘Let’s think, why is our hypothesis rejected for this year?’</td>
<td>‘We come to the conclusion that our data cannot confirm our hypothesis.’ ‘If we administer this survey each year, we can flag who is at risk for grade repetition.’ ‘What effect has the change in our school policy on our data?’</td>
<td>‘Thus, we have not enough pupils to perform reliable analyses.’ ‘If all teachers keep track of their grades like this, we can perform t-tests like this in the future.’ ‘How can this significant correlation result in a non-significant result on the T-test?’</td>
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<td>Internalisation</td>
<td>Data team members discuss what knowledge was important or unexpected, or discuss the strengths and weaknesses of their theory. They practice or gain experience.</td>
<td>‘I never knew the difference between boys and girls was this large.’ ‘Let’s make this test ourselves, to see what our pupils need to master.’</td>
<td>‘Our computer programme offers much more data to frame our problem than I was aware of.’ ‘We are not surprised by our data.’</td>
<td>‘The datateam procedure provides a structure to study our problem.’ ‘Let’s do some additional T-tests, just to practice.’</td>
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Furthermore, differences in the process of knowledge creation between the two data teams were found. For example, team Fairview evaluated the data they had collected more often than team Lincoln, which represents a difference in content. The log files and the status reports confirmed this. For example, the trainer wrote down in Fairview’s log files that the team members were able to critically evaluate their data and see what the limitations of those data were. Furthermore, Fairview’s data team members wrote down several limitations of their data in their status report. In contrast, the trainer wrote down in Lincoln’s log files that the team members sometimes worked too quickly. In addition, Lincoln’s data team members noted the small number of students as the only limitation of their data in their status reports. The differences between Fairview and Lincoln will be described more extensively in the paper.

Scientific and Scholarly Significance
Currently, micro-process studies on what teachers actually do in professional development contexts on data use are substantially underdeveloped (Little, 2012). Furthermore, research on the process of knowledge creation is scarce (McFayden & Cannella, 2004). The present study addresses these issues by conducting a micro-process study on knowledge creation in data use, thereby making knowledge creation a concretely recognizable behaviour. Above that, it is important to get a better understanding of how people learn over time (Nonaka, von Krogh, Voelpel, 2006), as it is likely to influence the effectiveness of teachers’ professional development. This study can serve as a starting point in determining whether certain knowledge creation processes are more effective than others, to further support effective data use in schools.

References
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Authors, 2010
Authors, 2012
Authors, 2013
Authors, 2014

Word count: 1999 (max 2000)