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► To cite this version:

Yvonne Liljekvist, Jorryt van Bommel, Ann-Christin Randahl, Cristina Olin-Scheller. Multi-theoretical approach when researching mathematics teachers' professional development in self-organized online groups. Eleventh Congress of the European Society for Research in Mathematics Education, Utrecht University, Feb 2019, Utrecht, Netherlands. hal-02418200

HAL Id: hal-02418200

<https://hal.science/hal-02418200>

Submitted on 18 Dec 2019

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Multi-theoretical approach when researching mathematics teachers' professional development in self-organized online groups

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Abstract: Teachers worldwide are using social media as a professional development resource. In studying social media as 'a place' for teachers' professional development, we investigated large Facebook groups with themes connected to teaching and learning in compulsory schools. The interaction in these groups was analysed within the framework of systemic functional grammar. In order to reveal knowledge known and shared by teachers as a community, we have also used Shulman's (1987) framework. Most posts received responses and this response is in line with the expected response pattern. The speech functions 'Questions' and 'Offers' were most common. Further, most posts addressed subject specific knowledge. The multi-theoretical approach used when researching mathematics teachers' professional development in self-organized online groups showed that these large Facebook groups facilitated professional learning.

Keywords: Functional grammar, mathematics teachers, PCK, professional development, social media.

Introduction

Studies have shown that Swedish mathematics teachers, to a large extent, participate in self-organized online groups both while working as well as during their free time (e.g., van Bommel & Liljekvist, 2015; van Bommel & Liljekvist, 2016). Moreover, participation in online communities is a global phenomenon: teachers worldwide are using social media as a professional development resource (e.g., Bissessar, 2014; Patahuddin & Logan, 2015; Tour, 2017). Hence, in studying social media as 'a place' for teachers' professional development, we investigated large Facebook groups with themes connected to teaching and learning in compulsory schools. It is well known that the subject being taught is in the centre of teachers' work (e.g., Kansanen & Meri, 1999; Shulman, 1987). Subject-specific Facebook groups (e.g., mathematics education) in an online teacher community may therefore imply a higher potential for professional development, and the subject-specific theme (e.g., mathematics for primary school) of some of the teacher self-organized online groups make these groups particularly interesting to study.

If we want to understand the conditions for informal professional learning in online communities better, we have to acknowledge the change of the setting and develop theories that take such change into account (Liljekvist, 2017; Liljekvist, van Bommel, & Olin-Scheller, 2018). Our study investigate these online communities at three levels: descriptive level (van Bommel & Liljekvist, 2016), interaction level (Randahl, Olin-Scheller, van Bommel, & Liljekvist, 2017), and the motivational level. These three levels give us an opportunity to answer the questions: how and what

do teachers discuss in the groups. However, this paper goes beyond such a question and addresses the theoretical frameworks we used to capture a variety of aspects of this practice, in order to identify signs of a professional approach (Talbert, 2010) in these communities. Further, the paper addresses the need to go beyond a specific theory when researching this phenomenon and a brief description is given of how the analytical framework was adapted to the context and empirical findings.

According to Little (2002), locating professional development in teachers' communities of practice directs attention to three considerations: (I) the representations of practice (e.g., how school practices become known and shared); (II) the practice orientation (e.g., whether or not the teacher community improves teaching, and how this interaction advances or impedes teacher learning); (III) the interaction norms (e.g., how participation and interaction are organized, and how this organization supports teacher learning and practice reform).

Hence, to understand how these practices become known and shared, the interaction in these groups was analysed within the framework of systemic functional grammar (Halliday & Matthiessen, 2013). Due to Facebook's construction with posts and comments, language (in a broad sense) is used to initiate exchanges in all conversations, for giving and demanding information, goods, and services. In addition, when analysing the practices represented and to reveal knowledge known and shared by teachers as a community (Little, 2002), we have used Shulman's (1987) framework. These two frameworks allowed us to categorize teachers' professional communities both in a general way and in relation to subject-specific education. Combining the two frameworks gives us more than two single descriptions: it provides us with a possibility to deepen the analysis of our data and reveals other aspects of mathematics teaching.

Analytical framework

Speech functions as enacting interpersonal relations

People use language to interact with others or to express their view about the world and how they interpret it. Within the framework of Systemic Functional Linguistics (SFL), this is described as the meta functions of the language (Halliday & Matthiessen, 2013). Halliday and Matthiessen distinguish between three meta functions of language, that is, its ideational, interpersonal, and textual functions. The ideational function is a matter of expressing how one sees the world and how one interprets this experience. The interpersonal function concerns how the text creates a relationship between speaker and listener. Finally, the textual function concerns aspects that make language relevant, which is sometimes looked upon as a "help-function" to organize and mediate.

Dealing with relation-making processes in online groups, we concentrate on the interpersonal function. In a conversation, the speaker not only plays an initiating role in exchanging information, but also requires something of the listener. "Typically, therefore", Halliday & Matthiessen (2013, p. 135) conclude, "an 'act' of speaking is something that might more appropriately be called an **interact**: it is an exchange, in which giving implies receiving and demanding implies giving a response" (bold in original). In the semantic system of speech function, anyone can initiate either a giving or a demanding exchange in the conversation. That is, we can give or ask for information and we can offer someone something or ask someone to do something. These four primary speech

functions: statement, question, offer, and command (see, e.g., Halliday & Matthiessen, 2013) were mapped on the posts in a group. It is therefore possible to analyse what the teacher wanted to accomplish when posting in the group by asking what speech function was used.

Further, the response given can be analysed as either *expected* or *discretionary* responses (Holmberg & Karlsson, 2006). For instance, the desired response to a question is an answer and the discretionary response is to neglect to answer. Hence, it is possible to uncover interactional patterns in online groups. For example, when making a statement, a member of a group can acknowledge as well as contradict a particular matter, indicating that statements may initiate discussions. Another example: if posts mainly evoke the desired responses, this could indicate a community of trust. Finally, when posting a question, a teacher expects someone in the group to have the answer as well as being willing to give it. In this way, questions can reveal the knowledge base of the group.

Disclosing the shared professional knowledge

In the knowledge base framework, Shulman (1987) outlines seven categories that he suggests constitute the teacher's understanding needed to promote comprehensive student learning. His framework incorporates teacher awareness of various educational aspects, such as content, pedagogy, and organization: content knowledge (CK); general pedagogical knowledge (PK); curriculum knowledge (CuK); pedagogical content knowledge (PCK); knowledge of learners (KoL); knowledge of educational context (KEC); and, knowledge of educational ends (KEE).

Together these categories serve as a way to visualize the shared professional knowledge in these Facebook groups, organized by and for teachers. However, we learnt from our empirical material that three of the categories (i.e., CK; PCK; and KoL) were difficult to differentiate from each other (van Bommel & Liljekvist, 2016; Randahl et al., 2017). These categories appeared simultaneously in many posts, hence, we decided to use an overarching category (PCK+) in further analysis, as we did not need a finer-grained analysis in this part of the study. By doing so, we adopt the framework to the Scandinavian/German educational tradition where the relation between the teaching, studying and learning activities in the classroom "the didactic relation" (e.g., Kansanen & Meri, 1999) is considered the professional knowledge base.

Method

The data were collected from large Facebook groups. The groups are formed and maintained by teachers, that is, self-organized and not initiated by schools, the Ministry of Education, researchers, etc. It is plausible that every member in the group has a connection to the education field, since the administrator of the group checks a member's affiliation to a school when entering the group. Through membership, one can post and comment. At the time of data collection, the groups were open for the general public to read. In this paper, we include the results from the analysis of three strategically selected Swedish Facebook groups with a theme connected to mathematics education, each with, at time of data collection, between 2000 and 15 000 members. The groups are labelled MA1–3.

By scrutinizing the activity pattern in the groups, a stratified random sample of posts could be conducted based on time of the school year (for a detailed description see van Bommel, Liljekvist,

& Olin-Scheller [2018]). This method makes it possible to draw conclusions of the interaction on the groups as a whole. Eighty-four to ninety-eight initial posts were collected per group with a total of 1762 responses to these initial posts. The average amount of responses per initial post differed from 3.1 in MA3 to 10.1 in MA2. The interaction sometimes contained images (77 in total), documents (13 instances) or links to other sites (229 instances).

The posts were categorized using the analytical framework developed from speech functions (Halliday & Matthiessen, 2013) and the knowledge-base framework (Shulman, 1987). Coding reproducibility was ensured via a multi-step process, where both inter and intra coder reliability was examined. All four authors were involved in the coding process, and all data was coded by at least two persons. Furthermore, the responses on the posts were analysed to confirm the coding of speech functions, as the response validates the speech function (e.g., Holmberg, 2011). Finally, the internal consistency of the categories was controlled for by scrutinizing all posts in each category, to ensure that all posts coded in each category were consistently coded. The procedure described, in which we recorded every step in the sampling, coding, and categorization, made it possible to backtrack, retrace, and correct errors made in the coding process.

Data

Below, four examples from our data are given (translated into English for this paper), including one or two of the responses to give some insight in the direction of the conversation. The examples will be referred to in the section results and the categorizations for each framework are stated in brackets, along with the number of responses.

Example 1: (Question, PCK+, 23 responses, 2 likes)

Initial post: Hi, I would need some tips for a thematic theme on length. The students are in grade 2 and have not previously reviewed cm, dm, m or how to measure. Anyone who has some good / cool lesson tip / tasks I could use. Thanks in advance!

Response: Estimate how long things are, then measure...

Response: We take one-meter-ropes and dm-ropes out to the forest and try to find objects of such length.

Example 2: (Question, CK, 13 responses, 4 likes)

Initial post: We discussed the definition of a circle in our team – What would you say, does a circle have one side or no side at all?

Response: No sides, closed curve

Example 3: (Offer, PCK+, 6 responses, 163 likes)

Initial post: We measure outdoors! An elephant of 3.5m, a whale of 15m and a crocodile of 6m 🐾 [Several images of outdoor work included]

Response: 🐾😊Fun! What a cute crocodile!

Example 4: (Statement, PCK+, 0 responses, 7 likes)

Initial post: Problem solving increases student performance in mathematics. [link to blog]

Results

Interactional patterns exposed by speech functions

Each post was analysed with a focus on the interpersonal function, which concerns the relationship-making process (Table 1). The four speech functions, that is, statement, question, offer, and command, convey what the teacher wants to accomplish when posting in the group. The speech functions ‘Questions’ and ‘Offers’ dominated as shown in Table 1.

Table 1: The distribution of speech functions in each group

	Statement	Question	Offer	Command	Total
MA1 (<i>n</i> =90)	5	48	34	3	90
MA2 (<i>n</i> =84)	9	44	25	6	84
MA3 (<i>n</i> =84)	8	12	56	8	84
Total (<i>N</i> =258)	22	104	115	17	258

To examine the interactional patterns and exchanges of the teachers posting in these groups, the responses to each post were analysed. The results show that 85.3% of all posts get responses. Most responses (80 %) are in line with the expected response pattern, that is, what the teachers wanted to accomplish when posting in the groups. In the examples above, we see that the questions received numerous responses (Example 1 and 2) whereas the statement (Example 4) did not receive any responses at all.

Knowledge addressed

To indicate the practice known and shared (Little, 2002), Shulman’s (1987) framework was used for the analysis. Using Shulman’s categories, the content of the initial posts could be analysed giving a descriptive overview of the content addressed by the teachers in these communities. These descriptive results were then combined with the previously described results regarding the interaction patterns in each group. As Questions and Offers dominated, we focus on these two speech functions (Table 2).

The analysis showed that most *Questions* deal with PCK+, that is, issues regarding subject-specific teaching and learning. Example 1 illustrates such posts. This overall pattern is similar in all groups (see Table 2). However, few questions were raised in MA3 so the pattern is not as distinct as in the other groups.

Further, the results regarding the *Offers* in the posts show that, similar to the category *Questions*, mainly subject specific knowledge (PCK+) were shared (Table 2) as illustrated by Example 3. In MA3, a few more posts offered content knowledge (CK), similar to Example 2. MA3 also distinguished itself from the other groups in the number of posts unrelated to Shulman’s framework (38.2%). Many of these posts contained mathematical jokes or humorous video clips related to mathematics.

Summary

The interaction that is the foundation of the Facebook groups is centered on asking for and sharing subject-specific knowledge (PCK+). Most posts received responses, and the responses were of the expected kind. The online groups were therefore mainly used as forums for making subject-specific education known and shared, but, broadly speaking, not as forums for discussion. Having used a stratified random sample, conclusions can be drawn regarding typical interaction patterns in large self-organized groups.

Table 2: Knowledge addressed in Questions and Offers

Knowledge base	Questions				Offers			
	MA1	MA2	MA3	Total	MA1	MA2	MA3	Total
PCK+	33	23	6	62	22	12	16	50
CK	2	6	4	12	0	2	11	13
PK	2	8	0	10	4	2	2	8
KEC	4	5	2	11	1	0	1	2
KEE	3	2	3	8	3	3	4	10
Total	44	44	15	103	30	19	34	83
Unrelated	7	5	0		3	5	21	

Discussion

In this paper, we have shown how two different frameworks enlighten different aspects of our data. When combining these frameworks, a new dimension of the data becomes discernible in terms of the way in which the mathematics teachers use self-organized online groups to advance their professional collaboration and professional development. More specifically, we were able to analyse what teachers wanted to accomplish when engaging in such groups. Further, we could see which parts of the teaching practice became visible. This is an important result, as it is an empirical question of whether the characteristics of groups of teachers working together are those of a community where professional development may occur. Since teachers' professional community is extended to social media (Liljekvist et al., 2018; Macià & García, 2016; Tour, 2017), we aimed at empirically investigating teachers' interaction in self-organized groups, addressing subject-specific knowledge, in order to understand how the groups are used as resources for professional development. The multi-theoretical approach used shows that these large Facebook groups display the characteristics of groups of teachers that merits professional development.

The teachers' online interaction is oriented towards practice to enhance students' learning; therefore, as Little (2002) illustrates in her studies of within-school teacher communities, the issues raised are closely tied to the teachers' everyday professional lives. The subject-specific themes of the groups seem to structure the interaction towards the PCK+, which could be described as the centre of teachers' knowledge base, or more specifically, the "didactic relation" between the

teaching-studying-learning activities (Kansanen & Meri, 1999). The teaching practice that becomes known and shared (Little, 2002) in the three Facebook groups is characterized by a focus on pedagogical content knowledge, learners, and the material and methods used in the classroom. In forthcoming studies, it is now possible to go further and inquire into posts and comments to reveal the individual themes within the PCK+ category, for instance, what kind of subject is at play, and if and how teachers learn in these communities.

The representations of practice in the groups display the same pattern in what teachers want to accomplish when posting; they request knowledge from and offer knowledge to colleagues, and illustrate and share practices. This is in line with our understanding regarding professional learning communities in schools (cf. Little, 2002). By combining systemic functional grammar and the knowledge-base framework, we can go beyond the context of social media interaction and explain how teachers use the resources in self-organized groups to develop their collective knowledge on pedagogical and subject-specific issues related to their everyday practice. Furthermore, these three Facebook groups are used in only a limited way as an arena for debating and discussing school policy matters. This is indicated by the small proportion of statements (22 of the 258 relevant posts), by the fact that most statements get responses that merely confirm the content in question, and by the educational aspects focused on in the posts. Here, a focus on educational context and educational ends would have indicated an interest in such matters. Discussions around such issues might occur in other Facebook groups with such themes. We want to conclude that the willingness to respond and to share knowledge and teaching methods in the self-organized groups facilitates rather than impedes professional development.

Acknowledgment

This work was supported by the Swedish Research Council under Grant number 2015-01979, and by the research group ROSE (Research on Subject-specific Education). Magnus Kallin supported in the data collection and Jari Appelgren in the data analysis.

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