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Incidents of professional growth in members of professional learning communities – a case study

1. Introduction

Teacher education is widely regarded as a key to influence on future generations. Mostly, the focus lies on pre-service teacher education (which lasts years), but the decades spent in-service are often disregarded. It is only recently that modern developments like the increased demand for digital and mathematical literacy have put the need for teacher professional development (PD) in the focus of attention. Consequently, educational administration as well as institutions like DZLM (*Deutsches Zentrum für Lehrerbildung Mathematik*, German Center for Mathematics Teacher Education) have taken on the responsibility for mathematics teacher PD. In this context, professional learning communities (PLCs) have gained importance.

2. Theoretical background

A group of teachers can be classified as a successful PLC, if they possess five characteristics, according to Newmann et al. (1996, p. 181f.): (1) shared norms and values, (2) a focus on student learning, (3) reflective dialogue, (4) de-privatizing of lessons, and (5) teacher collaboration. PLCs are regarded as a promising tool for teacher professional development (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006) and have been widely studied. They are understood as offering individual teachers a chance for professional improvement. As PLC members share their experiences and reflections with their fellow teachers, they can be classified as multipliers and it makes sense to explore the professional development effected by participation in a PLC. Our research question can be phrased as follows:

(RQ) What incidents of professional growth are reported by members of a PLC originating from a PD course on inference statistics?

3. Circumstances of the study

The PD course on inference statistics that prompted the PLCs in this study was designed and tested by DZLM mathematics educators and researchers (Oesterhaus & Biehler, 2014; Biehler, Griese, & Nieszporek, submitted). It stretched over several months and covered the complete statistics content for upper secondary level (including hypothesis testing) in combination with other issues (e.g. using simulations to promote understanding) in five days.

Individual participants of the course initiated PLCs with colleagues from their schools to promote the implementation of the course content.

During PLC meetings, selected elements of the PD course were presented and discussed, according to the needs and wishes of the PLC members, before and while some of them were involved in teaching statistics.

4. Methodology

After the PLC meetings had been completed, selected PLC members were interviewed after they had taught statistics in their classes. This study focuses on one member of one PLC, who has a teaching experience of more than two decades, but had not taught hypothesis testing for 20 years and stochastics at upper secondary level only in the year before.

The guided interviews were contrived for the broader research purposes of a bigger study and thus covered numerous aspects, among them the individual's benefit for their PD connected to the PLC, and cooperation among teachers. For the research focus presented here, interviewees' utterances were examined for passages referring to professional growth. Following the ideas of qualitative content analysis (Mayring, 2015), categories were found for the professional development that was reported.

5. Results and discussion

The categories of professional growth are presented by declining order of frequency. The mathematics teacher and PLC member "Vic" reports most often (8 codings) how he saw himself as learning, subsumed in the category *teacher as learner*. He advanced towards hypothesis testing via teaching basic mathematics classes in the year before (without hypothesis testing), and now teaching an advanced class (Vic_1, 00:51:54). His aim was to feel more secure about hypothesis testing ("um selber Sicherheit zu kriegen", Vic_1, 00:47:00), and the human factor in his class let him dare to admit that at some points, he had to think again and revisit the issue in the next lesson ("und ich mich wahrscheinlich dann deswegen auch häufiger getraut habe, zu sagen: An der Stelle weiß ich nicht weiter, da muss ich nochmal drüber nachdenken. […] Ich konnte beim nächsten Mal sagen: Ich habe da mal noch drüber nachgedacht und mir ist das noch eingefallen.", Vic_1, 01:05:25). Vic states he profited a lot from the subject-specific input in the PLC sessions and the new ways of approaching and considering statistics ("Vor allen Dingen hat es mir viel gebracht, deine Art, in der Stochastik anzugehen, zu durchdenken, selber fitter zu werden und mich sicherer zu fühlen", Vic_1, 01:07:40).

Vic also offers *reflections* on his teaching (7 codings). He regrets not having a broader range of tasks available ("vielleicht hätte ich mich breiter aufstellen können von den Themen her", Vic_1, 00:48:21), as he mostly reverted to classic contexts. He sees options for improvement in regard to his teaching of hypothesis testing in offering more meaningful contexts, verbal phrasings, and allowing lesson time for understanding a task before students start doing calculations (Vic_1, 00:50:00).

Consequently, Vic draws conclusions for his *future teaching* (5 codings) of hypothesis testing. He intends to enlarge his collection of strong tasks ("Natürlich will ich versuchen, meinen Aufgabenfundus dann jetzt zu erweitern, mal zu schauen, ob ich andere geeignete Aufgaben finde, die vielleicht besser passen, als die, die ich jetzt genommen habe", Vic_1, 00:47:59), of which he found several in the material of the PD course (Vic_1, 01:08:11, 01:08:35) and to consciously reserve time for the discussion of a problem before students start attacking it ("Ruhe reinbringen in die Stochastik, also lieber zweimal lesen, dann vielleicht da erst nochmal eine kurze Plenumsphase machen", Vic_1, 00:50:00), as he had noticed students working away on their own on a problem without having fully grasped its structure, with the result of incorrect concepts sinking in (Vic_1, 00:50:00). Specifically, he mentions errors of the first and second kind and acceptance / non-rejection of the null hypothesis (Vic_1, 00:50:00) as needing more lesson time on appropriate phrasing.

Vic also describes the *cooperation among teachers* (3 codings) at his school, i.e. mainly him cooperating with the colleague teaching a parallel course in advanced mathematics. They exchanged tasks and examinations, and they discussed their teaching approaches (Vic_1, 01:06:51) and how these appealed to their students ("wir haben uns da immer ausgetauscht, wie gut das angekommen ist oder wie schwer es Schülern gefallen ist", Vic_1, 01:07:40). This made Vic realize that he was less innovative than his colleague ("Mir hat es sehr viel gebracht, weil ich dadurch […] andere Zugänge habe, andere Arten, darüber nachzudenken", Vic_1, 01:07:56), which encouraged him to attempt to be more adventurous in the future.

In sum, we see that in this case study, the incidents of professional growth concentrate on how this specific teacher advanced in terms of pedagogical content knowledge. This is a category that is not contained in the list of characteristics for successful PLCs, it may be closely connected to the unpopular statistic content. There is evidence of reflection, which happened in dialogue and as self-reflection. The detailed exchange about teaching specificities implies de-privatization of classroom work, though there was no sitting in on each other's lessons. It is clear that Vic's focus is constantly on student

learning, which is obvious in his detailed and unique observations on students' learning obstacles and successes. That Vic draws positive conclusions about his experience in teaching hypothesis testing, despite the challenges he had to face, raises hope that the PLC made a difference to his PD.

6. Research perspectives

The analysis of one PLC member's professional growth can only be one step in the exploration of the effects of PLC participation that lies at the core of our greater study. However, it is not the first step, as we have looked into Vic's attitude towards the learning and teaching of mathematics before (Griese, submitted). Apart from widening these analyses to more members of the PLC project, as next steps it is planned to explore PLC members' tasks and tests used when teaching hypothesis testing, and to look for correlations between their attitudes, the evidence for professional growth, and their tasks and tests. And finally, to search for qualitative and theoretical corroboration that (some of) these correlations are causal.

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