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Agricola, Bas; Van der Schaaf, Marieke ; Prins, Frans; van Tartwijk, Jan

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**Title (100 characters, max 100 characters incl spacing)**

Professional Growth in Research Supervisors' Pedagogical Content Knowledge as  
Result of Lesson Study

**Authors**

Agricola, B.T., van der Schaaf, M.F., Prins, F.J., & van Tartwijk, J. (2019)

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Lesson study is a professional development program that combines teachers' active engagement and observation of teachers' lessons. During a lesson study teachers collaborate in a lesson study team. In this study, four participating research supervisors have developed, taught, evaluated and redesigned a supervision meeting with a focus on undergraduate students' research skills. During so-called research lessons, supervisors experimented with open questioning and giving positive feedback instead of giving instruction and explanations. As a result, the participating supervisors expected their students to substantiate, argue, and consider the choices they made. We aimed to identify the impact of this lesson study approach on research supervisors' professional development and specifically on their pedagogical content knowledge (PCK) as most important learning outcome. Triangulation by method was applied to measure supervisors' learning outcomes and learning activities; learning reports, videotaped lesson study meetings, and exit interviews were analyzed on indicators of change (e.g. 'I have learned'). Coding results showed two different learning outcomes and four different learning activities. Each learning outcome, and the corresponding activities were connected to the four domains of the Interconnected Model of Professional Growth. Different pathways for each supervisor's PCK were determined by constructing pictorial representations per supervisor. This study shows that lesson study is a promising professional development method that can have an impact on research supervisors' PCK. Our supervisors followed different pathways of PCK change, in which the learning activities of considering your own practice and getting ideas from others contributed the most to these changes.

**Summary (600-1000 words incl references) Current word count 999**

## **Introduction**

Lesson study is a professional development program that combines teachers' active engagement and observation of teachers' lessons. During a lesson study teachers collaborate in a lesson study team; they develop, teach, and observe a lesson, and examine its impact on students (Lewis & Hurd, 2011). The observation and focus on student learning in lesson study is the key to teachers' pedagogic development (Cajkler, Wood, Norton, & Pedder, 2014). Lesson study can improve teachers' thinking and practice as a result of increased knowledge of subject matter and instruction (Lewis & Hurd, 2011). In this study, teacher learning is defined as: "An active process in which teachers engage in *learning activities* that lead to changes in knowledge and beliefs and/or teaching practices" (Bakkenes, Vermunt, & Wubbels, 2010, p.536). Different learning activities lead to different *learning outcomes*. We operationalized teachers' learning outcomes as changes in research supervisors' pedagogical content knowledge (PCK). Research PCK is the blend of content and pedagogy, and includes teachers' orientation to teaching research courses, their knowledge of the research curriculum, of assessment, of students' understanding of research, and of instructional research strategies (Magnusson, Krajcik, & Borko, 1999). The Interconnected Model of Professional Growth (IMPG) of Clarke and Hollingsworth (2002) can be used to determine pathways of change in teachers' knowledge and practice. We addressed the following research question: How do the learning activities of a lesson study approach contribute to changes in research supervisors' PCK?

## **Method**

The lesson study team consisted of five members, the lesson study facilitator and the four research supervisors who worked at a bachelor of health program at a

Dutch university. The teachers supervised their students in their final year, during their undergraduate dissertation for 20 weeks (30 ECTS; 840 hours). We used a lesson study intervention as a professional development program for our research supervisors with four different phases during three lesson study cycles (Wood & Cajkler, 2016). The four participating research supervisors developed, taught, evaluated and redesigned a supervision meeting with a focus on undergraduate students' research skills. During so-called research lessons, supervisors experimented with open questioning and giving positive feedback instead of giving instruction and explanations. As a result, the participating supervisors expected their students to substantiate, argue, and consider the choices they made.

Triangulation by method was applied to measure supervisors' learning outcomes and learning activities; learning reports, videotaped lesson study meetings, and exit interviews were analyzed (see Table 1). Coding of the data was conducted in four steps. First, we applied an indicator of change to each segment of the data. Second, we coded each segment to one of the five PCK components. Third, we determined which activities caused the knowledge component to change, and coded these to one of the four learning activities. Fourth, each learning outcome and learning activity was coded to one of the four domains of the IMPG (see Table 2). An IMPG pictorial representation of the PCK pathways was constructed per supervisor and per data source.

## **Results**

Coding results of the learning outcomes showed two types of PCK change: Knowledge of instructional strategies (e.g. 'I have learned how quickly I am giving feedback'; T2 Exit interview), and Knowledge of students' understanding of research

(e.g. ‘Students would like answers to all their questions, they want to know if they are on track’; T3 Learning report2).

Four different types of learning activities were reported: Considering own practice (e.g. ‘I would like to stay alert on not giving instruction immediately, but first asking the student what they already know or have searched for, or what they think is the best option’; T2 Learning report1), Getting ideas from others (e.g. ‘I have learned from discussing and observing the supervision meeting of the research lesson; T3 Learning report4 ), Experimenting (e.g. ‘Two students wanted to use a statistical test and I said to them: you first have to find out for yourselves, I can help you putting the data in SPSS, but you really have to do it yourselves; T1 Exit interview), and Experiencing friction (e.g. ‘This experiment did not go as planned, students might be frustrated on the short term, but hopefully in the long run, they become more independent; T4 Learning report2).

In Figure 1, the PCK pathway of instructional strategies is depicted for the exit interview of Teacher1. This pathway originates in the External Domain (entry point), as this supervisor got ideas from others during the lesson study meetings. This learning activity led to a change in the PCK of instructional strategies in the Personal Domain. With this newly achieved PCK, the supervisor experimented in the Domain of practice, and considered her own practice with students in the Domain of Consequence in which she experienced friction.

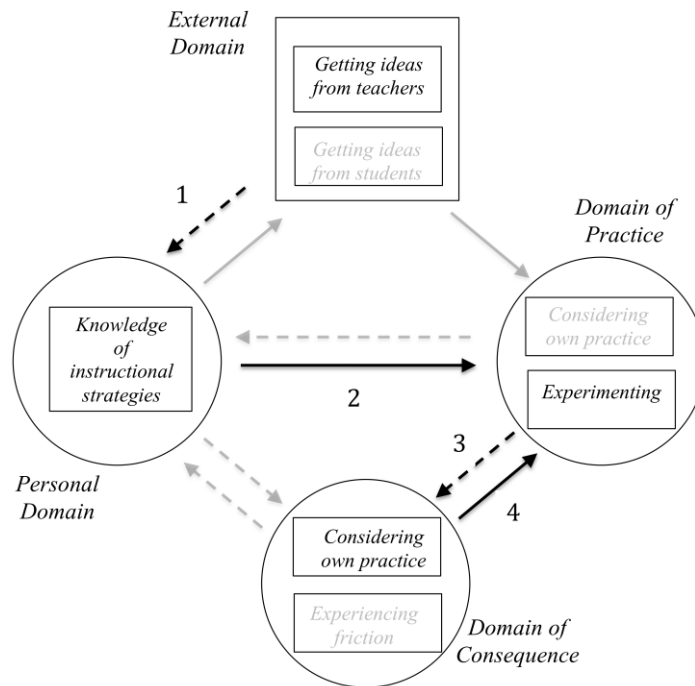


Figure 1. Pictorial Representation of Pathway of PCK of Instructional Strategies (Teacher1/Exit interview)

## Discussion

This study shows that lesson study is a promising professional development method that can have an impact on research supervisors' PCK. As a result of their participation in a lesson study supervisors' PCK changes were merely found for their knowledge of instructional strategies and their knowledge of student's understanding of research. Our supervisors followed different pathways of PCK change, in which the learning activities of considering your own practice and getting ideas from others contributed the most to these changes.

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Table 1.

*Overview of data gathering during lesson study phases*

LS Phase	Meeting	LS instrument	Measures	T1	T2	T3	T4	
Cycle 1 March-May	Preparation	LS meeting 1	Discrepancy analysis	Questionnaire 1				
		LS meeting 2	CIMO logic	Video observation 1 Learning report 1				
	Teach and observe	LS meeting 3	LS preparation form	Video observation 2 Learning report 2				
		LS meeting 4	LS preparation form	Video observation 3			A	
	Discussion	Research lesson	Observation form					
	Evaluation	Teacher-student	Student interview					
		LS meeting 5	LS preparation form	Video recording 4 Learning report 3				
	Cycle 2 May-June	Preparation	LS meeting 6	CIMO logic	Video observation 5			A
			LS meeting 7	LS preparation form	Video observation 6			A
		Teach and observe	Research lesson	Observation form				
Discussion		Teacher-student	Student interview					
Evaluation	LS meeting 8	LS preparation form	Video observation 7				A	
			Learning report 4				N	
Cycle 3 June - July	Preparation	LS meeting 9	LS preparation form	Video observation 8	A			
	Teach and observe	Research lesson	Observation form					
	Discussion	Teacher-student	Student interview					
	Evaluation	LS meeting 10		Video observation 9		A		
Questionnaire 2 Teacher interview								

Note. LS= Lesson Study; A = absent at LS meeting; N = learning report was not handed in

Table 2.

*Final coding scheme for indicators of change, learning outcomes, learning activities, and domains of IMPG*

Code	Definition
<b>Indicator of change</b>	<b>An indicator of change is the entry point for a pathway of knowledge.</b>
Change in teacher knowledge	The teacher used the expression of I have learned, I know how, I understand why etc.
Change in teacher practice	The teacher used the expression of Now I am doing, I used to do this but now I am doing that, I tend do more etc.
<b>Learning outcomes</b>	<b>Each indicator of change is coded with a learning outcome; one of the five types of pedagogical content knowledge</b>
Assessment	Knowledge of methods of assessment, how to assess student learning, and knowing which parts of content knowledge must be assessed
Curriculum	Knowledge of the curricular goals, how to implement/plan research curriculum
Instructional strategies	Knowledge of how to transform content knowledge into teaching strategies, e.g. which strategy works and when.
Student understanding	Knowledge of areas of student difficulty, knowing which concepts students find difficult to learn, which problems they experience, which misconceptions they have, which content knowledge they miss
Teaching orientation	Knowledge about their own goals and beliefs regarding teaching content knowledge to students, teachers' conceptions.
<b>Learning activities</b>	<b>Every learning outcome is the result of one or more learning activities during the lesson study, the pathway continues</b>
Considering own practice	The teacher reflected on his/her own teaching practice and/or on student learning/functioning
Experiencing friction	The teacher experienced a completely unexpected event or realized their usual teaching approach did not work any longer
Experimenting	The teacher purposefully tried out a new teaching strategy or new approach in practice
Getting ideas from others	The teacher got notice of the view or practice of another teacher, or got notice of the view of students or practice supervisor
<b>Domain of IMPG</b>	<b>Each coded learning outcome and corresponding learning activities are connected and coded to the domains of the IMPG</b>
Domain of consequence	The teacher considered their own practice and reflected on student learning or student functioning as a consequence of their acting
Domain of practice	Teacher reflected on their own teaching practice and/or tried out a new teaching practice, and/or experienced something new and unexpected
External domain	The teacher got his/her idea from other teachers, or from assignments during a lesson study meeting, or from reading literature.
Personal domain	The teacher refers to a change in teacher knowledge