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Blankman, M.C.M.

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4. Learning to teach geography for primary education: results of an experimental pro- gramme

Abstract

Students training to become primary school teachers appear to have little awareness of the core concepts of geography (teaching). To ensure that future primary school teachers are able to develop their pupils' geographical awareness, a six-week programme was developed. The characteristics of this programme are: principles of good geography teaching, conjunction and a recurrent structure during training, modelling and reflection. The question is answered what the effects are of this programme on the development of pedagogical content knowledge (PCK). The results indicated that the programme has a positive effect on the domain-specific PCK development in the short term.

Keywords

primary teacher education, pedagogical content knowledge, geography education, modelling, reflection.

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4.1. Introduction

The purpose of this study is to investigate a programme for primary student teachers that aims to develop student teachers' pedagogical content knowledge (PCK) for the subject of geography. (Future) primary teachers need to be able to teach their primary school pupils effective geography lessons. This requires, amongst others, that they have insight into the importance of the (school) subject for children, the main geographical issues, and how children learn geography. Although student teachers and primary school teachers are usually able to give geography lessons in primary schools, primary teacher educators experience that they have little awareness of the core characteristics of geography and geography teaching (Blankman, Van der Schee, Volman & Boogaard, 2015). Additionally, they are not always convinced that geography is an important subject in primary school.

Primary teacher educators believe that it is necessary that their students develop their PCK for the subject of geography during teacher education. However, they believe that their students only partly reach the desired level of PCK at the end of teacher education, due to a limited number of teaching hours for the subject of geography, a lack of focus on subject matter, and a widely varying knowledge base of student teachers when entering teacher education (Catling, 2004; Catling & Willy, 2009; Morley, 2012; Blankman, Volman, Van der Schee, & Boogaard, 2015).

Several authors have argued (Martin, 2000; 2005; Corney, 2000; Catling, 2004; Alkis, 2009; Lane & Coutts, 2012; Morley, 2012) that it is important to take into account the preconceptions – the images of geography and teaching – of student teachers because they influence their thinking about teaching and classroom practice. Research also shows that student teachers fall back on their memories of the geography lessons they themselves were taught at school: mostly representing a knowledge-oriented and informational view and the teacher who transfers information (Catling, 2004; Bradbeer, Healey, & Kneale, 2004; Martin, 2005).

In addition to the formal, knowledge-oriented, geographic experiences at school (the academic knowledge), Martin (2008a) distinguishes another source for learning: informal geographical experiences in the world (everyday knowledge), experiences that are not recognised as geographical by most of the primary student teachers. She also suggests that a barrier exists between the formal and informal sources of learning and that it is the teacher educators' task to remove this barrier so primary student teachers can use their everyday geographical experiences as a learner base. These everyday geographies could provide a suitable starting point from which to develop student teachers' teaching the subject of geography in primary school.

In this study a programme was designed and evaluated that promotes the development of pedagogical content knowledge of geography in primary teacher education. The programme develops Martin's (2008b) ideas about the potential of everyday geographical experiences for teaching into a set of design principles by integrating them with

basic principles of good geography teaching and teacher education. The programme with characteristics as explicit modelling, reflection and transfer aims to give student teachers insight into the characteristics of good geography lessons and tools to design and practice these lessons.

4.2. Theoretical Background

4.2.1. PCK

To successfully teach a subject (e.g. geography) in primary school, (student) teachers need pedagogical content knowledge (PCK) (Shulman, 1986; 1987). PCK is concerned with subject matter for teaching and consists of two main components: (1) domain knowledge that is transformed so it becomes comprehensible to students and (2) knowledge about student conceptions and preconceptions and common student learning difficulties.

Although the PCK framework has become an accepted framework, there is no generally accepted conceptualisation (Berry, Loughran, & Van Driel, 2008; Van Driel, Verloop, & De Vos, 1998; Depaepe, Verschaffel, & Kelchtermans, 2013). PCK is a dynamic concept that is defined in different ways by educational researchers. Several scholars (Cochran, King, & DeRuiter, 1991; Grossman, 1990; Turner-Bisset, 1999) argued for a PCK-concept in which knowledge components are more explicitly part of PCK. Turner Bisset (1999) e.g. developed a comprehensive model of knowledge bases for teaching in which PCK is seen as an overarching base. She distinguishes three types of knowledge relating to content knowledge or subject matter knowledge: substantive knowledge, syntactic knowledge, and beliefs about the subject. The substantive knowledge consists of the facts and concepts of a discipline (the knowing that). Syntactical knowledge refers to the ways and means by which the knowledge has been generated and established (the knowing how). Beliefs about the subject finally refer to the impact that personal orientation and conceptions towards a subject have on teaching a subject (Turner-Bisset, 1999, p. 43).

PCK is considered the synthesis of all knowledge needed to be an effective teacher. It is the transformation of subject matter, pedagogical and content knowledge into a unique form, “the only form of knowledge that impacts teaching practice” (Gess-Newsome, 1999), p.10). It is both an external and internal construct, as it is constituted by what a teacher does, what a teacher knows and the reasons for the teacher’s actions (Baxter & Lederman, 1999, p. 158) or in other words a teacher’s use of particular teaching procedures (*how*) with particular content (*what*) for a particular reason (*why*) (Loughran, Berry, & Mulhall, 2012).

Comparable to the previous and building on Turner Bisset (1999), Martin (2005) formulated three questions (student) teachers need to ask themselves: what am I going to teach, how am I going to teach it, and why am I going to teach it in this way? In this

way (student) teachers learn how to rework the subject knowledge so it can be taught effectively (Lambert, 2009b).

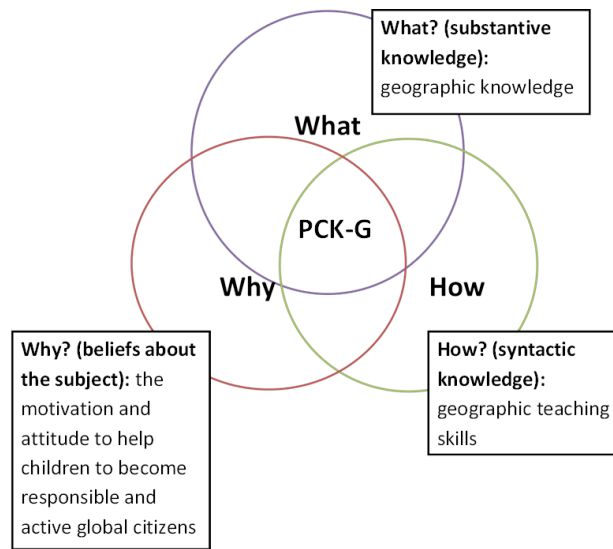


Figure 4.1. PCK for the subject of geography

In this study, we take these three questions as a starting point for a PCK model for the subject of geography in primary education: (1) what am I going to teach (substantive knowledge): the geographic knowledge, skills and drive to be taught, (2) how am I going to teach it (syntactic knowledge): the teaching skills needed to help children learn geography and (3) why am I going to teach it in this way (beliefs about the subject): the attitude to help children become responsible and active global citizens. This last question has a normative interpretation widely accepted in the field of geography (Haubrich, 1992; Geography Education Standards Project, 1994; Bednarz, Heffron, & Huynh, 2013).

We consider these questions the three most important questions student teachers should ask themselves when preparing their geography lessons for practice. They also form the fundamentals of a curriculum model for learning to teach geography in primary education.

4.2.2. PCK-G: the integrated knowledge needed to teach geography

PCK-G (Figure 4.1) is the type of integrated knowledge that is unique to teachers teaching geography; it is what teaching geography is about (Cochran, King, & DeRuiter, 1991).

Geography (*what*) can be described as the science that seeks to explain the character of places and the distribution of people, features and events as they occur and develop over the surface of the earth and it is concerned with human-environment interactions in the context of specific places and locations (Haubrich, 1992). Geography, in other words, is concerned with space and place (Gersmehl, 2008), and geographic key questions usually begin with or relate to Where is it? What is it like? Why is it there? How did it happen? What impact does it have? (Haubrich, 1992). Authors have added the concept of change and the key question: How does it change? (Van der Schee, 2000), and the key concept of perspective: Who is saying what? (Taylor, 2008). Another important geographic concept is scale (Catling & Willy, 2009). The geographical scale at which we examine a phenomenon can affect the observations we make (zooming in or out provides a different picture).

To be able to answer the geographic questions above, students need geographic literacy or consciousness. Van der Vaart (2001) used the concept 'geographic consciousness' to refer to "a combination of a way of thinking and a certain geographic knowledge base." He distinguishes three key competencies: (1) knowledge about world phenomena, processes and distributions, including topography, (2) issues of place and space, such as inequality and sustainable development, and (3) geographic skills, such as map skills (Van der Vaart, 2001, p. 19). The first two competencies focus on geographic knowledge (content). The third competency refers to the skills needed to 'do geography': the ability to ask geographic questions, to use geographic sources of information and to apply geographic thinking skills (KNAG, 2003; 2008). The US Joint Committee on Geographic Education distinguishes the same competences (Joint Committee on Geographic Education, 1984).

In the literature also the concept of "geographic drive," is used, defined as: "A certain level of geographic (enquiry) motivation, which refers to the willingness to study the characteristics, functioning and problems of the world around us" (Favier, 2011, p. 12). A geographic drive is supposed to help (student) teachers to develop the attitude (*why*) to support children to become responsible and active global citizens (Haubrich, 1992; Martin, 2006b). (Student) teachers in turn should realize that knowledge, skills and drive must be taught in conjunction and in a recurring structure when the aim is to develop a geographic worldview and knowledge and understanding of spatial issues in pupils (*how*).

Based on the above-described concepts, in this study we use a framework of seven characteristics of good geography teaching, as shown in figure 4.2. First, there are five geographic core questions that help to investigate phenomena and processes on planet earth as a geographer (What / substantive knowledge): *Where is it? Why is it there? What do I see if I zoom in or out? How does it change in time? and What are the consequences, advantages and disadvantages?* These five interconnected characteristics are based on geography education literature (Gersmehl, 2008; Taylor, 2008; Van der Schee, 2000). In addition, there are two instructional characteristics, not unique to the subject of geogra-

phy (How / syntactic knowledge): *How can I start the lesson in a motivating way?* and *How can I end the lesson in a way that promotes transfer?* Starting from an everyday geographic problem (a motivating start), pupils and their interests are the starting point for learning (Dewey, 1897). In this inductive way pupils are challenged to join the lesson (Martin, 2006a; Gersmehl, 2008; Catling & Willy, 2009). After this start the geographic questions are discussed and finally, each lesson ends by reflecting on the subject. In this way student teachers help their pupils to become conscious of the essential aspects of the lesson, a situation that promotes transfer to new situations (Korthagen & Vasalos, 2005; Korthagen & Kessels, 1999).

Characteristic	Explanation
Geographic characteristics (What)	
1. Where is it?	Describe what you see and where you see it, preferably using, e.g., a map, an atlas, a globe etc.
2. Why is it there?	Explain what you see (through the relationship between man and nature).
3. What do I see if I zoom in or out?	At other levels of scale, you may see different things. Zooming provides a different picture.
4. How does it change over time?	Describe the situation in the past and/or in the future.
5. What are the consequences, advantages and disadvantages?	The effects (or pros and cons) are viewed from different angles.
Instructional characteristics (How)	
6. How can I start the lesson in a motivating way?	The lesson starts in a way that challenges pupils to participate in class (using an everyday spatial problem).
7. How can I end the lesson in a way that promotes transfer? (Discuss the special and the general)	At the end of the lesson, there is a discussion about the usefulness of knowing something about the subject of the lesson.

Figure 4.2. Characteristics of a geography lesson

4.2.3. Teaching PCK-G in primary teacher training

Designing a programme in which attention must be paid to the development of PCK for the subject of geography, within a limited number of hours, is a challenge. We discuss a number of design principles on which, according to the literature, such a programme could be based.

Modelling and reflection

Different from other forms of higher education, teachers in teacher education teach about teaching. Implicitly or explicitly, they are their own models that show certain teaching principles during their classes (Swennen, Lunenberg, & Korthagen, 2008). "How they teach is the message" (Russell, 1997). Teacher educators therefore should demonstrate

or 'model' the behaviour that they expect their students to show in practice (Loughran & Berry, 2005; Swennen, Lunenberg, & Korthagen, 2008). Swennen et al. (2008), use the term 'congruent teaching', referring to a teaching methodology of the teacher educator that is in accordance with the teaching methodology that he or she wants to promote in the student teachers. Congruent teaching, however, does not merely entail modelling, it combines modelling, explaining the choices made while teaching by giving meta-commentary and linking those choices to relevant theory (Swennen, Lunenberg, & Korthagen, 2008). (Explicit) modelling combined with theoretical reflection facilitates translation of the teaching methodology that is being modelled to the student teachers' own practices and understanding of that methodology (Lunenberg, Korthagen, & Swennen, 2007).

Explicitly modelling the thoughts and actions that underpin the practice has been argued to lead to more powerful teaching and learning about teaching (Loughran & Berry, 2005, p. 197). Moreover, this may contribute to closing the gap between theory and practice. Student teachers are encouraged to consciously reflect on what they have learned and to apply their knowledge and skills in their practice in primary school (Loughran & Berry, 2005; Lunenberg, Korthagen, & Swennen, 2007; Korthagen, Loughran, & Russell, 2006; Swennen, Lunenberg, & Korthagen, 2008).

Connecting everyday and academic knowledge

Catling and Martin (2011) make a plea for courses in initial teacher education that engage student teachers to connect with their personal or everyday geographies. They distinguish between everyday geographical knowledge (practice) and academic geographical knowledge (theory), in which everyday geographical knowledge refers to the knowledge pupils and primary student teachers take to school. Both forms of knowledge (the everyday and the academic) need to be included in the curriculum. The dialogue between these forms of knowledge deepens and improves the understanding of both (Catling & Martin, 2011).

In the programme that is evaluated in this study, the following design principles are therefore central:

- a. *principles of good geography teaching* are integrated in a framework which is used during each session, the characteristics are trained in conjunction and in a recurrent structure.
- b. *explicit modelling* is applied to explain the teaching approaches and to link them to relevant theory (Swennen, Lunenberg, & Korthagen, 2008).
- c. *reflection* is used to link practical knowledge about geography teaching to theory and thus to promote transfer (Lunenberg, Korthagen, & Swennen, 2007).

- d. *everyday geographical knowledge* is connected to academic geographical knowledge by starting each session from an everyday/personal geographical example (Catling & Martin, 2011).

According to our opinion, this offers opportunities for the development of the PCK of primary student teachers for the subject of geography.

4.2.4. Research question

Based on the design principles described above, a programme was developed for primary student teachers named *Consciously Teaching Geography (CTG)*. Its aim is to develop student teachers PCK for geography through stimulating the conscious use of the characteristics of good geography teaching by means of explicit modelling and reflection and by connecting everyday and academic geographical knowledge. We expect that students who attended this programme will be better prepared to teach geography in primary school.

This leads to the following research question:

What are the effects of the programme Consciously Teaching Geography on the development of the PCK components: Substantial knowledge (what), Syntactic knowledge (how), and Beliefs about the subject (why) of first year students in primary teaching?

4.3. The intervention

The core of the intervention is made up of the experimental programme *Consciously Teaching Geography*, including sample lessons, an instruction manual and a training session to prepare the teacher educators to be able to appropriately conduct the programme.

4.3.1. The programme

The programme *Consciously Teaching Geography* was developed and piloted in close collaboration with other teacher educators. The design principles were discussed in three focus group meetings. Once the programme was developed, it was tested and adjusted in two pilot rounds.

Over the programme of five 90-minute meetings, first year primary student teachers work on developing their PCK for the subject of geography (see Figure 3.8). At the start of the programme, the activities focus on raising student teachers' awareness of their own image of geography and their preconceptions. Thereafter, these conceptions are compared with the geographies reflected in everyday activities (Martin, 2008a), e.g. their journey from home to school or the breakfast they ate that morning. Each meeting subsequently starts with an everyday spatial problem. During the meetings all seven characteristics of a good geography lesson are paid attention to (see Figure 4.2). The

framework of the seven characteristics is used to help student teachers to make the connection between everyday geographic experiences and the core academic concepts of geography. Each meeting the teacher educator models the characteristics of a geography lesson step by step, in a sample lesson (Figure 3.7 gives a sample lesson from the programme), by providing meta-commentary through which a translation to the student teachers' own practice takes place, and a connection is created between exemplary behaviour and theory.

4.3.2. Preparation

Seven geography teacher educators conducted the programme. They received a four-hour training. During this training participants first were informed about the theoretical background of the intervention. Subsequently they experienced a sample lesson from the course, followed by a discussion that focused on the characteristics of the programme and the role of the teacher educator in it. Thereafter a lesson was built up together with the participants, starting from an everyday geographic issue and using the seven characteristics (see Figure 4.2) as a tool. Also attention was paid to how to model the several steps. Finally, the participants were set to work designing a lesson themselves. In this way participants get used to the method of the programme.

4.4. Method

4.4.1. Design

To find an answer to the research questions a quasi-experimental research design with control groups and pre-post testing was used. First a pre-test was taken to measure student teachers PCK for geography prior to the intervention. Next, the experimental groups followed the CTG programme (the intervention), and the control groups followed the regular geography lessons. In both types of classes (experimental and regular) the same topics were taught, such as how to ask geographic questions, how to use maps, atlases and geographic textbooks during classroom practice. Only the approaches differed. To measure the development of PCK two post-tests were taken. The first post-test took place directly after the course. The second post-test was a retention test two months after the programme had finished (see Figure 4.3).

Prior to the intervention a meeting was organised in which all teacher educators who participated in the study (of the experimental and control groups) were instructed in the purpose and the design of the intervention.

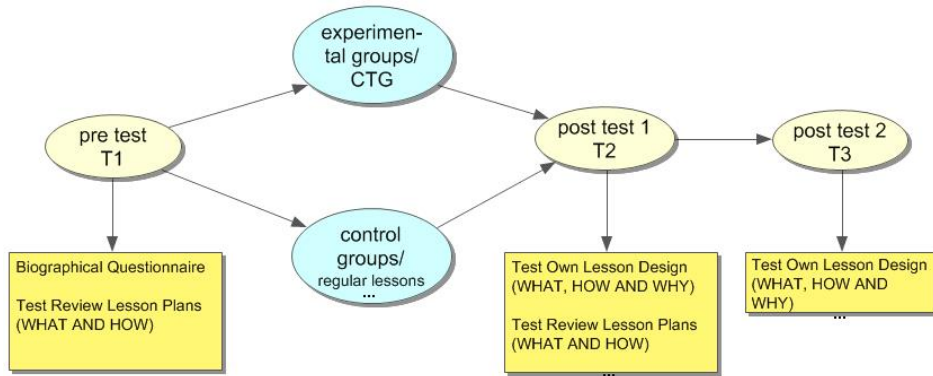


Figure 4.3. Design of the study

4.4.2. Instruments

To measure the effects of the experimental module a combination of a mixed-and multi-method study (Teddlie & Tashakkori, 2009; Greene, Caracelli, & Graham, 1989) was conducted. Quantitative analyses were applied to partially qualitative data and quantitative methods of data collection and analysis were used to examine complementary aspects of the same phenomenon: students’ PCK (Figure 4.4).

What is measured	Name of the instrument	When
1. Personal characteristics	Biographical Questionnaire	T1
2. Substantial WHAT and syntactic HOW - knowledge Understanding of the concept of a good geography lesson	Test Review Lesson Plans Test Own Lesson Design	T1, T2, T3
3. Beliefs about the subject WHY Consciously using the concept of a good geography lesson	Test Own Lesson Design	T2, T3

Figure 4.4. Instruments used in the study.

1. *Personal characteristics*: to collect some background information, a *Biographical Questionnaire* was answered by all students at the pre-test (T1) (age, gender, final exam in the subject of geography, interest in geography). In this way we were able to compare the experimental and control groups.
2. The *substantial knowledge (WHAT)* and *syntactic knowledge (HOW)* are measured together, based on the principle that both forms of knowledge are interrelated in a lesson. These forms of knowledge are combined in the seven characteristics of good geography teaching (see Figure 4.2). Two tests were used to measure this: the *Test Review Lesson Plans* (pre- and post-test) and the *Test Own Lesson Design* (post-test only).

In the *Test Review Lesson Plans* student teachers had to comment on five short lesson plans and to note which two aspects should be added to the lesson to make it a good geography lesson. Each aspect that was correctly listed resulted in one point (maximum score: 10 points). Figure 4.5 gives an example of such a lesson plan. The test was conducted in the pre-test (T1) as well as in the post-test (T2). The test is developed together with colleague researchers and is consistent with the intended goals, the development of substantive knowledge (WHAT) and syntactic knowledge (HOW). The content validity of the test was tested and approved during the pilot phase of the study.

Lesson plan Europe: Which country is on your dish today?

At the table of the teacher lies a pizza. The teacher asks the pupils if they know from which country a pizza originates.

The teacher asks one of the pupils to locate Italy on a map of Europe.

During a visit to the supermarket pupils look for products originating from other European countries.

Pupils discuss in groups whether their grandparents could buy those products in the Netherlands when they were kids.

To conclude the lesson, the teacher and the pupils talk about why it is useful to know something about importing products from other countries.

Task for the students:

Here you see a lesson plan for a geography lesson for age group 10-12. Two elements of a good geography lesson are missing. Please write down those two things.

(The two elements that are missing are: *why is it there?* (Why do we import products from foreign countries?) and the *consequences* (What are the pros and cons of importing products from foreign countries?))

Figure 4.5. Example of a lesson plan from the test 'Review Lesson Plans'

The substantial and syntactic knowledge of the student teachers was also measured by means of the *Test Own Lesson Design*. In this test student teachers had to design a lesson on a given everyday geographic issue. In designing this lesson, they had to use a format in which they had to answer three questions for each phase of the lesson: what does the teacher do, what do the pupils do and why do we do that in this way? (Figure 4.6). With the first two questions we aimed to measure the use of the characteristics of a good geography lesson, or – in other words – the substantial and syntactic knowledge (What and How). This test was conducted after finishing the geography course (T2) and was repeated after two months (T3). The quality of the instrument was tested and improved during two pilot rounds.

Therefore, both the *Test Review Lesson Plans* and the *Test Own Lesson Design* measured substantive and syntactic knowledge. The *Test Review Lesson Plans* was used

to measure whether student teachers were able to recognize quality in the work of others; the *Test Own Lesson Design* shows their ability to apply characteristics of good geography lessons themselves. We in other words looked at two complementary aspects (Greene, Caracelli, & Graham, 1989), with the aim to gain a better and more complete picture of the PCK development of student teachers.

3. *Beliefs about the subject (WHY)* are measured by the *Test Own Lesson Design*. If students could answer the question Why do we do that in this way? (Figure 4.6) they did demonstrate the conscious use of the characteristics of good geography teaching.

Subject:		Lesson is meant for year:
Learning objectives:		
1. What does the teacher do?	2. What do the pupils do?	3. Why do we do that in this way?

Figure 4.6. Scheme for developing a geography lesson

The degree of completeness with which the seven characteristics were applied in the *Test Own Lesson Design* was checked. If a characteristic was used (the first two columns are filled in adequately – we called this ‘sufficient use’), it was awarded one point. If a characteristic was used consciously (column 3 is also filled in adequately), an extra point was awarded. In total fourteen points could be obtained. In figure 4.7 a short example is provided.

1. What does the teacher do?	2. What do the pupils do?	3. Why do we do that in this way?
I ask one of the pupils to point on a map of the Netherlands where the river Rhine flows.	The pupil point to the river Rhine on the map	It is important to localise because it helps pupils to develop a geographic worldview.
sufficiently used		used consciously
1 point		1 point

Figure 4.7. Part of a lesson plan (characteristic *Where is it?*) about rivers in the Netherlands including the awarded points

Initially approximately 5% of the almost 400 *Tests Review Lesson Plans* and *Tests Own Lesson Design* were rated by two reviewers on the basis of a correction format. Both reviewers were involved in primary teacher training and familiar with the experimental programme. The scores of both reviewers for the tests were compared. Based on a number of discussion points, the correction format was further detailed and decision points

were formulated. This cycle was repeated (in which another 5% of the tests was rated), after which 100% agreement was reached. Afterwards one reviewer corrected the remaining 90% of the tests. In the appendix the rubrics for both tests can be found.

4.4.3. Participants

Primary teacher educators listed in the directory of the primary teacher educators' network of the Royal Dutch Geographical Association (of which nearly all Dutch primary geography teacher educators are members) were invited to take part in the study. Fifteen teacher educators volunteered to participate. Eleven teacher educators were selected to participate in the study and assigned to the experimental and control condition, based on the following criteria:

The programme should be organised into the regular programme of the institute so regular assessments could take place (prerequisite).

Experimental and control groups were matched in terms of student population (age, gender, former education, final exam in geography and interest in the subject) and matched as well as possible in terms of the urban character and ethnic diversity at the locations of the institutes. In this way, we aimed at forming comparable groups.

Eventually, almost 450 first year primary student teachers at the beginning of their training participated in the study: six experimental groups were formed with seven geography teacher educators and in total 248 student teachers, and six control groups were formed with five geography teacher educators and in total 201 student teachers.

4.4.4. Characteristics of the participating student teachers

Table 4.1 shows that the experimental group and the control group were broadly comparable. More than 80% of the student teachers were female, more than 40% took a final exam in geography at secondary school and more than half of the student teachers think geography is an interesting subject. The majority of the student teachers entered primary teacher training after five years of secondary education (senior general secondary education). On average, the student teachers in the experimental group (mean age 18.7 years, range 1.8 years) were somewhat older than the student teachers in the control group (mean age 18.4 years, range 1.3 years). This difference is significant, $t = -2.533$, $df 173.29$, $p < 0.05$. Therefore, age was included in the analyses as a covariate.

4.4.5. Data analysis

First, descriptive analyses were performed: means and standard deviations were calculated. Subsequently, analyses were conducted to answer the research questions.

Students in groups (classes) that were taught by different teacher educators followed the CTG programme. Therefore, it was expected that the results of students from the same group who were taught by the same teacher would be more similar to each other than to

the results of students from different groups. In other words, it was expected that the observations of individual students would not be independent of each other. A determination of the intraclass coefficient of the dependent variables involved (for the measurement moments separately) showed that the teacher educator indeed had a strong influence on the variable PCK-G WHAT/HOW as measured by the *Test Review Lesson Plans* and on the variables PCK-G WHAT/HOW and WHY as measured by the *Test Own Lesson Design*. Therefore, the analyses were carried out as a multi-level analysis with the teacher educator as a cluster.

Table 4.1. Characteristics of the respondents

Characteristics	% within exp. group	% within control group
Female students	83	82
Final exam in Geography	43	41
Geography is an interesting subject	52	53
Former education:		
- MBO (Senior secondary vocational education, e.g., teaching assistants)	31	28
- HAVO (senior general secondary education, 5 years)	63	65
- VWO (university preparatory education, 6 years)	6	8
Average age in years *	18.7	18.4

* = sign: $t = -2,694$; $df 415,470$; $p < 0,05$

The effects of the intervention on the development of primary student teachers' PCK (as measured by *Test Review Lesson Plans* and *Test Own Lesson Design*,) were determined by using a regression analysis. In this way, it was examined whether there was a significant difference between the participants in the experimental and control groups in the degree to which they were able to apply the characteristics of good geography teaching in a sufficient and a conscious way. The short-term effect was determined by a comparison of the experimental and control group test results just after the intervention. The long-term effect was determined by a comparison of the experimental and control group two months after the intervention ended.

Because the T-test showed that a significant difference in age existed between the experimental and control group, age was initially included as a covariate in both analyses. Where age did not show effect, it was removed from the final model.

4.5. Results

In the following section the effects of the CTG programme on the several aspects of PCK will be described.

4.5.1. The effects of the programme CTG on the PCK development

Table 4.2 gives an overview of the scores for the two tests that measure the PCK development of the experimental and control groups. The experimental group on average has higher scores on the post-test (T2) of the *Test Review Lesson Plans* than the control group. This is also true for the scores on the post-tests (T2 and T3) for the *Test Own Lesson Design*. What is striking is that the mean scores are relatively low for both tests and both groups. While there are some student teachers that score the maximum number of points (10 points for the *Test Review Lesson Plans* and 14 points for the *Test Own Lesson Design*), the scores for the majority of the student teachers are much lower.

Table 4.2. Descriptive statistics *Test Review Lesson plans and Test Own Lesson Design*

	T*	Group	N	Min	Max	Mean	SD.
Test Review Lesson Plans**	T1	Exp	248	0	7	1.2	1.10
		Contr	201	0	5	1.4	1.11
	T2	Exp	248	0	10	3.3	2.29
		Contr	201	0	4	1.2	1.12
Test Own Lesson Design Sufficiently used***	T2	Exp	231	0	6	3.0	1.46
		Contr	173	0	6	2.2	1.35
	T3	Exp	141	0	6	2.7	1.54
		Contr	75	0	5	2.3	1.06
Test Own Lesson Design Consciously used***	T2	Exp	231	0	7	2.0	1.59
		Contr	173	0	6	1.2	1.14
	T3	Exp	141	0	6	1.7	1.42
		Contr	75	0	4	1.3	1.20

*T1= pre-test, T2= post-test 1, directly after the course, T3= post-test 2, two months after the course

Max. score = 10 points, * Max. score= 7 points

4.5.2. The effects of the programme CTG on the development of Substantive and Syntactic knowledge in the short term measured by the Test Review Lesson Plans

Table 4.3 shows that at T=2, directly after the program, there is an interaction effect between T=2 and the experimental group: $b = 2.30$, $t(627) = 12.00$, $p > .05$ at the *Test Review Lesson Plans*. This effect is significant; at T=1 no significant effect was found. Also the experimental group had higher scores on the *Test Review Lesson Plans* ($t=8.96$, $p < .001$). The results of the test thus show that the experimental programme has a significant effect on the development of the substantive and syntactic knowledge (WHAT and HOW) of first year student teachers for the subject of geography.

Table 4.3. Predictors of substantive and syntactic knowledge measured by the Test Review Lesson Plans

Predictor	b	SE	df	t	p	95% CI	
						LL	UL
Intercept	4.23	.41	481.05	10.28	<.001	3.42	5.04
Experimental group	2.26	.25	28.47	8.96	<.001	2.78	1.75
Time	2.15	.13	647.17	16.61	<.001	2.40	1.89
Time * experimental group	2.30	.19	626.61	12.00	<.001	1.92	2.68
Age	-.048	.02	827.78	-2.41	.016	-.09	-.01

Note. b = unstandardized regression coefficient; p = two-sided; LL= lower limit; UL = upper limit.

4.5.3. The effects of the programme CTG on the development of Substantive and Syntactic knowledge and Beliefs about the subject in the short and long term measured by the Test Own Lesson Design

Table 4.4 shows that at T=2, the experimental group had higher scores on the *Test Own Lesson Design*- sufficient use (of characteristics of good geography teaching) than the control group. This difference is significant ($t = 2.48$, $p = .030$). There is no significant difference in score on the *Test Own Lesson Design* - conscious use (of characteristics of good geography teaching). As no pre-test was taken, no interaction effect could be included in the model.

Table 4.4. Occurrence of characteristics of good geography teaching in the short term (T2)

Dependent variable Parameter	b	SE	df	t	P	95% CI	
						LL	UL
Sufficient use							
Intercept	2.91	.28	11.19	10.41	<.001	2.31	3.55
Experimental group	1.00	.42	11.41	2.48	.030	1.95	.12
Conscious use							
Intercept	1.84	.29	11.46	6.43	<.001	1.22	2.47
Experimental group	.84	.42	11.68	1.97	.071	1.77	.08

Note. b = unstandardized regression coefficient; p = two-sided; LL= lower limit; UL = upper limit

Table 4.5 shows that on the second post-test (T=3) the experimental group did not score significantly higher on the *Test Own Lesson Design* - sufficient use and conscious use.

Table 4.5. Occurrence of characteristics of good geography teaching in the long term (T3)

Dependent variable Parameter	b	SE	df	t	P	95% CI	
						LL	UL
Sufficient use							
Intercept	1.15	.79	189.38	1.46	.147	.41	2.70
Experimental group	.52	.49	9.36	1.06	.318	1.63	.59
Age	.09	.04	255.19	2.38	.018	.02	.17
Conscious use							
Intercept	1.81	.22	9.83	8.16	<.001	1.32	2.31
Experimental group	.50	.37	9.43	1.38	.200	1.32	.32

Note. b = unstandardized regression coefficient; p = two-sided; LL= lower limit; UL = upper limit

Results show that the experimental programme had a significant positive effect on the use of the characteristics of a good geography lesson in the short term, that is, on the substantial (WHAT) and syntactic (HOW) knowledge of first year student teachers immediately after the course. In the long term (two months after completion of the course), the programme had no significant effect.

There is no significant positive effect of the programme on the conscious use of the characteristics of a good geography lesson, that is, the beliefs about the subject (WHY). This is true both in the short term (immediately after completion of the course) and in the long term (two months after the end of the course).

4.6. Conclusion and discussion

This study adds to our knowledge about how to enhance first year primary student teachers' development of PCK for the subject of geography. So far this is the first study into effects of the repeated application of characteristics of good geography teaching to help primary student teachers develop their PCK for the subject of geography. In this way it contributes to the research on characteristics of effective geography teaching.

The study shows that it is possible to develop student teachers' *substantive and syntactic knowledge* (WHAT and HOW) for the subject of geography by means of a short intervention with design principles like modelling and reflection, everyday geography and integrated characteristics of good geography teaching embedded into existing programs in primary teacher education. According to Rogers (2003) this embedding contributes to the usefulness of such interventions. In the long term, the effect of the programme on PCK development seems to fade away, which is not surprising, because no follow-up was given and subsequent classes were taught using the conventional method.

The programme had no significant effect on student teachers' *beliefs about the subject* (WHY). More time and practising seem to be needed before students are able to (consciously) use the characteristics of good geography teaching and to develop their PCK for the subject of geography in a more extended way. This is in line with Van Driel et al. (1998) who suggest that PCK is developed through an integrative process rooted in classroom practice, which implies that beginning teachers usually have little or no PCK at their disposal.

This study shows that the short intervention is a promising beginning. At the same time more is needed in terms of time, support and research in order to realize more sustainable results in teacher education. More research is needed, mainly in primary school practice, which is left aside in this study. Furthermore, it was found among secondary geography teachers that they are willing to adopt new strategies for learning as they become familiar with them through a hands-on process and with the opportunity to discuss the pros and cons of those strategies with colleagues (Leat et al., 2005). These authors also stress that, to make lasting changes, substantial support has to be offered by the school and the wider system. Swennen et al. (2008) emphasize that, besides knowledge and skills concerning congruent teaching, also a language is necessary in which teacher educators can discuss (congruent) teaching strategies with colleagues.

To summarise, and in connection with the course CTG, teacher educators should be given more time to practice e.g., in a hands-on course with opportunities for discussion with colleagues, the characteristics of the course and their knowledge and skills in congruent teaching. Furthermore, support from the teacher training institutes is needed to provide opportunities to integrate the characteristics of the course in the whole of the (geography) curriculum so students can become more experienced in using the characteristics of good geography teaching and apply them in practice.

Our results suggest it is crucial to offer primary school teachers courses for continuous professional development in which they train in hands-on sessions to develop their PCK for the subject of geography and familiarise themselves with new scientific insights on geography teaching. This would give student teachers opportunities to see 'the good example' during their primary school practice and bridge the gap between theory and practice.