Chapter 16

Tracing Teachers' Professional Growth from Updating Polytechnic Courses in Design Teams

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Introduction

Effective professional development of teachers is positively related to learning at the workplace, not only individually through classroom practices but also through collegial interaction and collaboration (Billett, 2009; Hoekstra, Beijaard, Brekelmans, & Korthagen, 2007; Tynjälä, 2008). Research on workplace learning shows that when people work alongside others, they observe, listen and participate in activities; this enables them to learn new practices and perspectives as well as to gain expertise (Eraut, 2007). According to Eraut (2007), the quantity and quality of learning among professionals can be enhanced by increasing opportunities to consult with and work alongside others in teams or temporary groups. In the educational research literature about teacher learning, communities of practice are considered important as settings for on-going teacher learning at the workplace that eventually aims to improve teaching practice and students' outcomes (Grossman, Wineburg, & Woolworth, 2001; Hord, 2004; Little, 2003). According to Wenger (2003), a 'community of practice' is a kind of grouping with three elements: mutual engagement in the task at hand; common negotiation of the focus of work; and development of a shared repertoire of knowledge and skills to effectively address work demands. Collaboration in teams or communities of practice is presented as an effective response to increasing change and as creating a knowledge-based workforce. One characteristic of communities of practice is teacher collaboration in small groups who (re-)design parts of the curriculum (e.g., courses, lesson activities). In this study, collaborative curriculum design in teams was considered to be a workable, cohesive strategy for effective professional development (cf. Burrell,

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Cavanagh, Young, & Carter, 2015; Millar, Leach, Osborne, & Ratcliffe, 2006; Nieveen, Handelzalts, Van den Akker, & Homminga, 2005; Simmie, 2007). The study focuses on teacher learning in curriculum design teams and aims to identify effective learning and development processes in these teacher teams while they (re-) design their courses. The study is part of a body of on-going research on teacher professional growth and collaborative curriculum design (e.g., Bakah, Voogt, & Pieters, 2012b; Handelzalts, 2009; Voogt et al., 2011).

Teachers' Learning and Collaborative Curriculum Design

Collaborative curriculum design is gradually gaining attention in education as a teacher professional development strategy and as a way to develop teacher ownership of curriculum innovation (Desimone, 2011; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Voogt et al., 2011). In the present study, polytechnic teachers collaboratively re-designed their curriculum in teacher design teams. A design team is defined as a group of at least two teachers, from the same or related subjects, working together on a regular basis, with the shared goal of redesigning and implementing (a part of) their common curriculum (Handelzalts, 2009). The design team concept provides teachers with a creative space to reconsider the teaching of their subject, the intellectual stimulus of working together, and the challenge to move their thinking forward; in this way, teachers are invited to become curriculum makers (Clandinin & Connelly, 1992; Simmie, 2007). Designing in teams is one current popular means by which teachers can collectively participate in curriculum design and fulfil their learning, social and intellectual needs. In fact, collaborative design has been identified as effective in bringing about teacher professional development (Borko, 2004; Deketelaere & Kelchtermans, 1996; Nieveen et al., 2005; Penuel, Riel, Krause, & Frank, 2009). A review of research on teacher design teams showed that design teams in which teachers collaboratively (re-)design a new curriculum, and also implement their design in their educational practice, contributed not only to the learning of individual teachers but also to improved classroom practice and student outcomes (Voogt et al., 2011).

For teachers, learning occurs in many situations in their practice (Peressini, Borko, Romagnano, Knuth, & Willis, 2004) and can be conceived from a cognitive and situative perspective. Whereas the cognitive perspective sees learning as a product, a change in the beliefs, knowledge and skills of individuals (Alexander, Schallert, & Reynolds, 2009), the situative perspective focuses on learning as a process that is fostered by interaction with the practices in which individuals participate. In the situative perspective, it is important to consider "individuals' acquisition and use of knowledge as aspects of their participation in social practices" (Greeno, 2003, p. 315). In addition, situated learning refers to how a person learns a particular set of knowledge and skills, assuming that the situation in which a person learns is a fundamental part of what is learned (Greeno, Collins, & Resnick, 1996). In sum, the situative perspective indicates that to trace teacher learning, we must take into

account both the individual teacher-learners and the physical and social systems in which they are participants (Putnam & Borko, 2000).

In this study, teachers' learning in design teams is viewed within both the situative and the cognitive perspectives. The professional development programme provided teachers with the opportunity to acquire knowledge in their respective subject domains, which can be classified under the cognitive perspective on teacher learning. In addition, the occurrence of situated learning among teachers is envisaged, due to the (re-)design of their courses in design teams and the implementation of the updated courses in try-outs. Individual teachers are particularly expected to learn from those practices insofar as such practices relate to their career. When professional development is organized in a collective manner, teachers share successful experiences and learn from each other (Gallagher & Ford, 2002). Through this approach, teachers utilize the instructional resources and skills of their peers to support their professional development and attainment of shared instructional and curricular goals (Glazer & Hannafin, 2006). To advance curriculum design teams as a teacher professional development strategy, this study argues for the importance of better understanding about how teachers make sense of their learning in teacher design teams. Specifically, this study documents the process of teacher professional development among polytechnic teachers who collaboratively redesigned their courses and conducted classroom try-outs of the updated courses.

The Interconnected Model of Professional Growth

In this study, the Interconnected Model of Professional Growth (IMPG) propounded by Clarke and Hollingsworth (2002) is used to identify learning processes that are fostered by teacher design teams aiming to (re-)design part of their curriculum (Coenders, Terlouw, Dijkstra, & Pieters, 2010; Voogt et al., 2011). The IMPG Model (see Fig. 16.1) is an empirically grounded model for investigating teacher learning. The IMPG distinguishes four separate domains in which change in teachers can take place. Three of these domains are part of teachers' professional life and may result in teacher change. The *Personal domain* reflects teacher's knowledge, beliefs and attitudes; when teachers acquire new knowledge and skills or develop new attitudes, change in this domain occurs. The *Domain of practice* encompasses teacher learning that is situated in all forms of professional experimentation (not exclusive to classroom experimentation). In this study, change in the domain of practice is concerned with teachers' (re-)design of their course in design teams and the implementation of the updated courses in classroom try-outs. The *Domain of consequence* concerns the outcomes of teaching for students. In this study, change in the domain of consequences occurs when teachers perceive the outcomes of the classroom try-outs as salient. The fourth domain, the *External domain*, is external to the teacher and deals with sources of information and other stimuli that support and facilitate change. Through the External domain, teachers become acquainted with new ideas, practices and/or strategies that are introduced and developed by others. In the

Fig. 16.1 The interconnected model of professional growth (Clarke & Hollingsworth, 2002)

present study, this refers to participation in a workshop and visits to industry sites. The model suggests that change in one domain is translated into growth in another through the mediating processes of “reflection” and “enactment”. Reflection refers to teachers’ thinking about their practice (‘reflection on action’) and during practice (‘reflection in action’) (Schön, 1987). Enactment in this study refers to the re-design and implementation of the polytechnic courses.

The mediating processes of reflection and enactment are represented as arrows linking the domains. The IMPG recognizes the complexity of professional growth through the identification of multiple growth pathways between the domains. Unique to this model is its depiction of professional growth as an inevitable and continuing process of learning, recognizing the mediating processes of reflection and enactment as the mechanisms by which change in one domain leads to change in another (Clarke & Hollingsworth, 2002). The interrelated nature of the four domains emphasises the complex nature of teacher professional growth and provides important considerations for teacher professional development. From this perspective, these four domains together constitute a teacher’s situated learning environment.

On the basis of the features of IMPG, teacher professional growth is investigated in this study as guided by the following research question: *How does teacher participation in (re-)design and implementation of polytechnic courses in teams impact their professional growth?* In this investigation, teacher professional growth is defined as positive change taking place in teachers’ knowledge, attitudes and skills (cf. Brown, Collins, & Duguid, 1989; Resnick, 1987).

Context of the Study

In 1993, the ten state-owned vocationally-oriented polytechnics in Ghana were upgraded to tertiary status to offer career-focused programmes in various domains. The tertiary status of the polytechnics became critical when the polytechnics were mandated to offer Bachelor of Technology degree programmes in 2007. Stakeholders then became concerned about whether the existing human and material resources of the polytechnic were adequate for the effective functioning of those institutions (Nsiah-Gyabaah, 2005). Although the original curriculum of the polytechnics was designed to cater for the human resource needs of industries, continuous update and evaluation of content are needed in order to meet the challenges faced by industries. In addition, studies have shown that polytechnic teachers in Ghana need to improve their knowledge and skills to match the tertiary status of the polytechnics (Gervedink Nijhuis, Bakah, & Akomaning, 2009; Nsiah-Gyabaah, 2005). The intervention in this study is part of multiple efforts to step up professional development for polytechnic teachers in the context of a curriculum reform initiative in Ghana.

A study by Bakah, Voogt, and Pieters (2012a) about polytechnic teachers' professional development needs revealed that teachers wanted to improve their knowledge and skills through industrial attachment. Industrial attachment is seen as an effective professional development activity for polytechnic engineering teachers to keep their vocational knowledge and expertise current, including their knowledge of technologies and practices commonly used in contemporary workplaces (Loveder, 2005). Bakah et al. (2012a) concluded that as a result of technological advancements, polytechnic engineering teachers saw the need to pursue relevant knowledge to improve their professional competence and be able to update their courses.

Based on the findings of Bakah et al. (2012b), curriculum design teams were adopted as a teacher professional development strategy at a polytechnic in Ghana. Teacher participation in curriculum design teams was organized as an intervention that lasted 14 weeks in total. The intervention included an introductory workshop, collaborative curriculum design activities to update engineering courses, industrial site visits by the design teams and implementation of the updated courses in classroom try-outs. The introductory workshop, which was held in the first week, included orientation for the teachers regarding curriculum design in design teams. The author was the main facilitator at the workshop and throughout the study. Starting from the second week, three teams of teachers, based on commonality of their subject areas, worked collaboratively to update their courses to suit current technological practices in industry. The teachers also visited industry sites in teams to acquire relevant information to make their courses more practical and relevant in content. In these visits they were also exposed to several technologies relevant to their area of study. For the most part, the teams worked at their own pace to complete the redesign of their courses. During the thirteenth and fourteenth weeks, teachers conducted classroom try-outs of the updated courses they had collaboratively designed in teams. The topics for the try-outs varied from programme to programme.

Methods

Design

This study employed qualitative methods for data collection and analysis in a multiple case study (Yin, 2003). The three cases were the three teacher design teams in the Production, Automobile and Electrical Departments of the Faculty of Mechanical Engineering at the Polytechnic in Ghana. Teachers in the three teams were the units of analysis.

Participants

Data for the study came from three design teams made up of male teachers from the Faculty of Engineering at a polytechnic that was selected because of its longevity and proximity to some major industries. The teachers worked in the Higher National Diploma (HND) programmes in Automotive Engineering (five teachers), Production Engineering (five teachers) and Electrical Engineering (six teachers). For the purpose of reporting on individual teacher professional growth, in the present study the sample was limited to six teachers (two selected from each team, based on longest and shortest years of service at the polytechnic). Background particulars for the teachers involved in this study (pseudonyms used) are presented in Table 16.1.

Data Collection

Two types of data were collected from teachers: (1) detailed field notes (in logbook) taken from group discussions in design activities, and (2) five face-to-face interviews on self-progress conducted throughout the study. There were five categories of semi-structured interview data collected from each teacher to find out about their experiences during the following team activities: industry site visits, collaborative design activities, teaching tryouts, perceptions of teamwork and teacher learning in teams. On average, each of the five interviews lasted 25 min, making the total interview time per teacher approximately 2 h and 5 min.

Data Analysis

All interviews were transcribed and coded using codes generated from the study. The Atlas-ti qualitative data analysis software (version 6.2) was used to code and analyse all the interview data. The communications in the transcriptions were

Table 16.1 Background particulars for teachers

Team	Teacher (pseudonyms)	Age	Highest academic standing	Years of teaching in polytechnic	Course	No. of students
Automotive	Melvin	54	Diploma	15	Workshop Process and Practice 1	18
	Julian	46	Master’s	1	Hydraulics 2	93
Electrical	Steve	64	Diploma	17	Electrical Machines 3	71
	Harry	26	Bachelor’s	2	Electrical Machines 1	81
Production	Ernest	69	Bachelor’s	21	Manufacturing Technology 2	49
	Leonard	38	Master’s	3	Engineering Processes 2	58

Fig. 16.2 Teacher learning networks

identified and coded using the deductive method of coding (Miles & Huberman, 1994). The codes developed were based on Fig. 16.2.

Two aspects of the domain of practice are distinguished in this analysis. P is used for activities related to teacher implementation of the re-designed courses, while P* is used for the design activities teachers conducted in the teams. Table 16.2 provides examples of codes based on the IMPG Model and the type of actions taken.

After all transcripts had been coded, the data were analysed either to describe the target variable(s), or to identify relationships between variables. The idea behind this was to establish the focus of the conversations between the participants when in

Table 16.2 Examples of deductive coding of the summaries

Code	IPMG model feature on which code is based	Example of action
Industrial attachment evaluation	E-External stimuli	Visits to industry
Course update evaluation	P* – Professional experimentation	Working in design team
Teaching tryout appraisal	P- Professional experimentation	Classroom implementation
Perceptions of design teams	S – Salient outcomes	Teachers' experiences
Teacher learning	K – Knowledge, beliefs or attitudes	Learning in design teams

the design teams, during their classroom interactions with students, and between the participants and the researcher. Inter-coder reliability (Neuendorf, 2002) of two coders was calculated using a random sample of 18 out of 30 interviews from 6 teachers, with an overall agreement of .89 (Cohen's κ). The method used for the analysis of the field note data was content analysis for the systematic description of the text. Major themes were identified and clustered (Miles & Huberman, 1994) based on the five categories of codes listed in Table 16.2.

Findings

In the ensuing sections, the reflection and enactment processes of the six teachers in the Automotive Engineering, Electrical Engineering and Production Engineering design teams, respectively, are presented (Fig. 16.2 identifies the coded elements of teacher learning networks that are included). This is followed by the growth paths that were identified through our analysis.

Individual Learning in Teams

Automotive Engineering Team

Melvin

During the development process, Melvin expressed optimism at advancing in knowledge in his subject area (*I*). He hoped to improve his course but had never thought that working in a team could be practical for achieving this purpose. Commenting on his knowledge of course design, Melvin stated:

I learnt the technicalities involved such as analysing the course structure (*b*, *P**). Collectively digesting the syllabus was so practical (*e*, *P**).

Melvin practiced the procedures of course design in a communal effort (3, P*). Having been equipped with information from industry, Melvin's knowledge had been enhanced (a), as he stated that:

At Mechanical Lloyd, I discovered their latest diagnostic tool for BMW vehicles and practiced it on a BMW 7-Series (a).

Melvin's acquisition of such knowledge enabled him to update his course (3, P*) and conduct his teaching tryout (3, P). Melvin taught *On Board Diagnostics*; commenting on his teaching, he said:

There are a lot of things I read and teach in the abstract, but things I encountered at the industry have helped me (a; 2, P). It's going to enhance my teaching and make it easier to explain things to my students (a, 3, b). I understood the diagnostic system and was able to relay the information to my students better (a; 3, P; b, P). It was a lively class as students discussed fault-finding in their groups (e, P).

Reflecting on his involvement in teamwork, Melvin revealed that:

I had the opportunity to interact with fellow teachers and learnt to tolerate diverse behaviours (e, P*)... It has been a lot of learning experience to listen to colleagues' ideas (b, P*).

Julian

Having spent a year at the polytechnic, Julian expressed enthusiasm about visiting industry sites with his colleagues (1). He had high expectations of older and more experienced colleagues in terms of drawing from their experiences with their courses and their ideas for course design (b, P*). Just like others in his team, he got involved in the course update, and said:

We all came to agreement that there was a need for a particular type of students' practical training, which was an important activity (3, P*). I learnt from my colleagues certain competencies that students need to possess as well as the need for a balance between technical and industry-specific skills (b, P*). It intensified my practical knowhow (a) and gave me ideas for the direction of my course update (3).

Julian visited industry sites in the company of other colleagues and stated that:

After undergoing servicing, the amount of pressure for the machine to operate on is calibrated on the computer; this actually broadened my understanding about the latest way of testing hydraulics of heavy-duty trucks (a).

Due to the knowledge acquired, he was able to update his course (3, P*). During the teaching tryout by Julian, he used pictures in PowerPoint to explain the maintenance of *Hydraulic Systems*. Commenting on the teaching, he said:

As we haven't got the physical components of these off-road trucks, we can now show them pictures of those components (3, P) rather than allowing them to just imagine as in previous lessons. I could see their interest in the lesson (e, P).

Julian recognised the influence of teamwork on his knowledge as depicted in his statement:

It is very beneficial to work in a team because we share ideas about what we do and what we need to do (*b, P**; 3, *P**). I discovered the mode of presenting the topic with colleagues' help (*b, P**) and it was successful (*e, P*).

Electrical Engineering Team

Steve

Steve had been involved in the development of courses at the national level, but had no experience in developing courses using information from industry on current technologies and so was curious. Having paid a visit to an industry site, this is what Steve had to say:

...I got to know that the voltages used for excitation at the turbo generators were far less than at the hydro-generating stations (*a*). In the hydro-generating stations, about 500VDC is being applied whereas turbo generators at thermal power stations have about 35VDC ... the range is very vast. All along, I thought they were injecting about 100VDC so 35V was shocking (*a*). Then the principle I knew came to the fore and makes me appreciate N*I as magnetomotive force, giving me a clearer picture of that mathematical expression (*I; a*). I got to know what excitations mean (*a*).

Pondering over the redesign of the course, Steve pointed out that:

We identified some learning needs to bridge the gap between our syllabus and industry competency standards (2, *P**) and I discovered that as a technical and vocational teacher, I cannot create situational learning experiences without an understanding of workplace contexts and changes (*I; b, P**). Such understanding made me draw on some practical knowledge from the industry visit (*b, P**; *a; 2, P**).

These observations by Steve further reveal that his discoveries during course design added to his knowledge (*b, P**). Having taught *Synchronisation*, Steve reflected on the lesson and new additions to the courses and students' reactions to the classes they took. He articulated:

If you should have a look at the course outline for Electrical Machines 3, it's really abstract and complex ... for there are some things that one cannot appreciate until a field experience (2, *P; I*). For instance when you talk about an exciter or armature reaction to students in class, they can't visualise it. But with that diagrammatic representation students were able to appreciate it (*e, P*) ... So today's teaching was successful in my opinion (*e, P*). Most of the students were happy (*e, P*). And one of the students said that: If we can do this every now and then, then it is going to make learning easier and more appreciable (*e, P*).

Steve reflected on the increase in students' motivation, which propelled his confidence in the knowledge he had attained (*c*). He also reflected on the change in his knowledge and skills regarding the course content (*d; b, P*) and its presentation (*e, P; d*). Concerning collaboration in the team, Steve said:

Teamwork for a moment changed my state of isolation in my area to working hand in hand with others (3, P*). For me, it was not only an eye opener (b, P*) but was also refreshing (e, P*) because even though there were some things I knew, in the team, I got to know much about them in a greater dimension (b, P*; c), for instance ... I was more inclined towards developing teaching material but I learnt in the team about also developing equipment concepts due to practical skill competencies (3, P*; 2, P*).

Steve got to improve his knowledge among colleagues in the team (b, P*) as he drew ideas from them (b, P*) and further contributed to improving teaching of the course (3, P).

Harry

Harry found it important to continually improve professionally, and added:

... as the world constantly changes, so I want to expose my students to current things so that when they get to the industry, they know what they are about (a).

Reminiscing about his industry site encounter, Harry stated that:

Although I know that GRIDCO uses SF6 circuit breakers, I had not seen one until we went there. I saw how the change-over switches and focus relays work, how to test oil and cool the transformers (a). The transformers I knew had separate cooling systems but with the modern ones I saw, they are incorporated (a). I knew tap changing the analogue way but I now discovered the new digitally operated transformers which save time and energy (a).

He was also quick to admit that:

There is now a lot of software development which our students need to know and I am going to teach them these (3, P; 2, P).

The course design facets were learning grounds for Harry, as he pointed out in the following quote:

Actually incorporating some new things in our pretty old syllabus builds a lot of confidence in me (b, P*). I discovered in the syllabus that though the principles with the old systems are the same, the operations change (b, P*).

Harry taught his class on *Tap Changing* and indicated:

It is very revealing, because with tap changing, we have always been teaching about the analogue type but this was an opportunity for me to introduce the digital system types to my students (3, P; 2, P). It was a livelier class than usual (e, P) to see students making useful contributions in class (e, P). They worked in groups on the transformers and it became student-centred unlike before (e, P).

According to Harry, teamwork offered *abundant learning opportunities* (e, P*; b, P*). He explained his assertion as follows:

I learnt to share my ideas with fellow teachers (b, P*; e, P*) and collaborate with others to build a strong knowledge-base for my course (b, P*) ... most of all I learnt to be creative

(*b, P**; *e, P**), became humble (*e, P**) and was open to change (*e, P**; *c*) ... I thought I was an expert in handling the course until it came to me as a big surprise that others have wonderful ideas to offer to improve it (*d; 4, P*).

About collaboration in the team, Harry said:

Individuals are doing their respective researches here and there, but collaboration in the team unearthed other teachers' research work (*e, P**; *c*) ... It was interesting ... to tap information from each other (*e, P**; *c*).

Production Engineering Team

Ernest

Change was the uppermost agenda for Ernest. His target was to bring something new into his course and into the classroom (*1*). Thus, he stated about the industry site visit that:

We learnt ... generally about foundry works and methods of joining metals which enhanced my knowledge (*a*). I learnt about how castings are repaired when they don't come out well (*a*).

The following are Ernest's observations during course design:

I found out how to come up with specific topics and aspects of the syllabus that we wanted to hammer on since they are core parts of the HND course (*3, P**). I had the idea not to teach students something which is antiquated (*b, P**). I learnt to impart occupationally oriented contents of skilled work ... subjects, tools, methods, technology (*b, P**). Most of all delving into the syllabus was a new learning experience for me (*b, P**).

During the teaching tryout, Ernest took his students through *Joinery Methods* and remarked:

Apart from an updated content (*a; b, P**), the delivery method was different (*e, P; c*) because I now had a lot of pictures from industry to support what I was saying (*2, P*); a lot of pictures and videos spoke for themselves (*2*). The students showed a lot of interest and asked more relevant questions than previously (*e, P; 3, P**). Indeed, my industry experience kept me at ease in our class discussion on the topic (*b, P*).

Ernest shared his thoughts about his lessons in the team, saying:

Teamwork paved the way for me to know from colleagues, things I never knew (*b, P**; *e, P**). I found out how to tolerate individual differences in the team (*4, P**) and I learnt to be circumspect in communicating information to be discussed (*4, P**). We collaborated to share ideas (*3, P**) and worked hand in hand to achieve set targets (*3, P**) ... that unity of purpose was there (*e, P**).

Leonard

Leonard was interested in acquiring relevant knowledge from industry to update his knowledge and his course, and looked forward to getting some hands-on training (1). He indicated the following about the industry site visit:

I encountered machines which earlier on I had never had the opportunity to operate myself like the radial drilling machine and vertical boring machine (a) ... I liked the experience (a). My confidence was reinvigorated (a). My students are going to benefit from this (2, P; 3 P).

The course design process also offered Leonard some learning experiences, which he described as follows:

At the onset, I got to know how to identify need areas in the syllabus (b, P*). I also expanded my knowledge on competencies for my course (a; b, P*). I now know competency standards are made up of units of competency (a; b, P*), which are themselves made up of elements of competency (a; b, P*).

Leonard taught *Hydraulics* during the teaching tryout and indicated that:

I realized that most of the students appreciated the format (e, P) ... the pictorial representation (e, P) and the PowerPoint presentation on the maintenance of hydraulic systems in heavy duty off-road trucks (e, P). One student said: ...Sir, things are a lot of clearer today (e, P).

In his remarks on teamwork, Leonard said:

Teamwork can never be downplayed since knowledge gained from my fellow teachers was valuable (b, P*; e, P*) ... In the team I acquired the idea of developing occupationally oriented tasks for students and confronting them with occupational problems (3, P*; 3, P). I tapped into the experience of others (b, P*) and developed in creativity (b, P*; e, P*). I also got to know that colleagues are always ready to help when you consult them (b, P*) and that it's not helpful to work in isolation ... especially in academia (e, P*). We all got involved and were ready to share ideas (c, 4; P*S).

Teacher Professional Growth as Depicted by the Enactment and Reflection Processes

Domain of Practice and Personal Domain

Tracing teacher professional growth revealed that individual teacher learning occurred most significantly between the *domain of practice* and the *personal domain*. Teacher participation in curriculum design activities increased knowledge of curriculum design and content. Analysing the course structure, incorporating competencies that students need to possess, balancing technical and industry-specific skills, and bridging the gap between the syllabus and industry competency standards

were among the concrete practical tasks and learning experiences in enactment that brought teachers face to face with their subject matter. Additionally, teachers' reflections on subject matter, delivery and outcomes in the teams enhanced interaction and knowledge sharing. Their participation in design teams was enactment-driven and improved their collaboration, making them discover how to share knowledge and ideas, communicate with others, be creative, broadminded and tolerant, as well as making them learn how to find information on their subject matter.

Teachers' presentation of subject matter was enhanced when they conducted teaching tryouts of the updated courses, an upshot of enactment. The success of classroom implementation also depended on the up-to-date knowledge teachers got from industry site visits and the skill to present subject matter to students, both of which were revealed in the enactment process and were shown to increase teacher confidence in the content.

External Domain and Personal Domain

Teacher learning was notably present between the *external domain* and the *personal domain*, as all the teachers became involved in the industrial site visit to learn about current industrial operations in place. In effect, the opportunities teachers had to reflect individually and as a team on the input provided by the industrial site visit augmented their knowledge and beliefs about their subjects. Apart from getting to know about relevant industrial trends, teachers individually handled equipment in brief training sessions to improve their hands-on experience. This was the case for all teachers except for Melvin and Julian. They visited hydro-electric generating stations and thermal plants where power is constantly flowing and could not be shut down at the time of their visit for them to use the equipment. The introductory workshop on collaborative curriculum design was a forum where teachers obtained more knowledge on course design in teacher design teams. Further, the interaction between teachers and the facilitator of the introductory workshop about course design also shows how reflection contributed to teachers' growth.

External Domain and Domain of Practice

All of the teachers except Julian expressed their experience of knowledge acquisition between the *external domain* and the *domain of practice*. The teaching try-outs were based on the updated courses and were also a learning ground for teachers, enabling them to practice what they had learned from the industry site visits. In this light, certain equipment and practical operations from industry were taught to students based on the teachers' field experiences. There were software developments and automated/digital systems which teachers encountered in industry and introduced in the classroom. A derivative of enactment was revealed during collaborative curriculum design, as teachers learnt to bridge the gap between the syllabus and industry competency standards, and design situational learning experiences based

on their understanding of workplace contexts and changes. Their design tasks called for documenting the newly acquired knowledge from industry to restructure their syllabi in ways that reflected the current needs of industries.

Domain of Practice and Domain of Consequence

Appreciable amounts of teacher growth took place between the *domain of practice* and the *domain of consequence*. The students showed a lot of interest in the topics, classes became livelier as they encouraged students' discussion. Clarity and presentation of topics were rated high as the presentation was supported with pictures from industry. When reflecting on the try-out, teachers used words such as "refreshing", "revealing" and "an eye opener".

There were consequences of working in design teams that emanated from the reflection process, such as tolerance of diverse characters and behaviours, seeking ideas from colleagues, unearthing of research ideas, learning to communicate with others, uniting with others to achieve set targets, humility, creativity, and being open to change.

Collaborative curriculum design brought to light salient teacher outcomes reflected in the implementation of their redesigned courses, such as discovering competencies, including industry skills in the syllabus, ensuring hands-on technical skills, being able to analyse the course structure, knowing certain competencies that students need to possess, being able to bridge the gap between the syllabus and industry competency standards and imparting occupationally oriented content about skilled work, among others.

Domain of Consequence and Personal Domain

Apart from Melvin and Julian, all of the other teachers displayed professional growth between the *domain of consequence* and the *personal domain*. This was primarily revealed through the reflection process. The teaching try-out propelled teachers' confidence in both the delivery method and the knowledge they had attained, and intensified their practical knowhow. Their knowledge and skills changed after modifying the course content and presenting it. Teacher collaboration gave them ideas that expanded their knowledge and contributed to updating their courses.

Discussion

This chapter reports the results of a study aimed at identifying teachers' learning processes in design teams that contribute to their professional growth. Data from interviews and field notes were collected over the 14-week journey of updating

courses and subsequent classroom tryout for six teachers in three different design teams. Next, we discuss in detail teacher learning as diagnosed by the enactment and reflection processes of the IMPG.

Teachers grew professionally during the cycle of collaborative curriculum design and the use of the redesigned curriculum in class teaching as diagnosed in all four domains of the IMPG (Clarke & Hollingsworth, 2002). In particular, their knowledge, attitudes and skills developed in the interaction with colleagues and industry during collaborative curriculum design and, ultimately, culminated in re-designed curriculum materials. The focus of the teacher design teams was on curriculum development and teaching; however, as an offshoot the process served as a learning experience for the individual teachers themselves, as was uncovered through analysis of the enactment and reflection processes. Implementation of the re-designed curriculum materials in the classroom was a crucial factor that contributed to professional growth, while reflection was mainly a pondering and intermediary factor, which helped to reinforce knowledge.

The IMPG unearthed details of teacher professional growth emanating from the teachers' own professional practices and the interdependence of multiple factors in diagnosing teacher change. Teacher professional growth had a situative (in the domain of practice and the domain of consequences; Greeno, 2003; Putnam & Borko, 2000) and cognitive (in the personal domain; Greeno et al., 1996) nature. The beliefs, knowledge and skills that were developed were situated in their practices in the classroom and in the collaborative curriculum design. Teamwork in teacher design teams enhanced individual professional growth, confirming that professional development can be pervasive when learning is viewed as a collective enterprise, as in professional communities (cf. Gallagher & Ford, 2002). Through a team approach, teachers continually utilized the instructional resources and skills of their peers to support mutual growth and attainment of shared instructional and curricular goals (Glazer & Hannafin, 2006). Therefore, this study contributes to characterizing the learning and development processes teachers are engaged in when actively involved in collaborative curriculum design. Further, the results pertaining to the growth outcomes in the four domains contribute to the discussion of the integrity of the knowledge acquired by these teachers, whether it has a situative or a cognitive nature, as stipulated by Greeno and Van de Sande (2007) and discussed by Alexander (2007) and Alexander et al. (2009).

Limitations

One might argue that the IMPG model (Clarke & Hollingsworth, 2002) and the approach to teacher professional development used in this study do not necessarily fit in the cultural context of Ghana's polytechnics. Gervedink Nijhuis, Pieters, and Voogt (2013) studied cultural differences between Ghana and the Netherlands in a

collaborative project aiming to contribute to the professional development of the polytechnics' heads of department. They concluded that curriculum design activities were affected by the cultural factors introduced by Hofstede (1980) and typified as Collectivism, Context, and Time. In our study, the influence of culture on stakeholders' values, and on the educational context in which the curriculum design activities were conducted and the curriculum would be implemented, became more obvious during the curriculum development process. The cultural factors identified by Gervedink Nijhuis et al. (2013) positively affected the introduction of collaborative curriculum design and the subsequent teacher learning. Based on their findings, Gervedink Nijhuis et al. (2013) advocated conducting an in-depth context analysis to serve as input for professional development and careful monitoring of the outcomes and impact of the professional development arrangement for the teachers and their practices. In the present study, the approach to professional development was based on a context analysis (Bakah et al., 2012a) and the sustainability of the intervention was investigated in a follow-up study (Bakah, Voogt, & Pieters, 2012c). The context analysis made explicit which cultural issues had to be taken into account in the design of the professional development arrangement and the analysis of the findings. The follow-up study resulted in clear (partly cultural) conditions for the sustainability of the approach for teacher learning and its impact on practice.

Another limitation of this study concerns the analysis of only self-reported data. All the references to professional growth are based on teachers' perception and awareness of their learning. That notwithstanding, professional development in the design process can be inferred from this study, and the IMPG helped to assess teachers' perceptions. Finally, another potential limitation concerns the narrow focus of the design activities by teachers, which was due to the limited period of 14 weeks for the design activities. However, the teachers were convinced that the design activities they carried out were a major step in the series of curriculum design activities ongoing in the polytechnics. The groups worked on their own during the design process, which is a gratifying sign for effective future attempts by teachers to update their courses.

Conclusion

Tracing teacher growth through the IPMG revealed how the teachers developed in their thinking during design conversations about curriculum design and subject matter update in teams. The analysis shows that the patterns of the participating teachers' growth have more similarities than differences, both between individual teachers and across the three design teams studied. This was observed in the ensuing discussion of the enactment and reflection processes. The groups evolved with time, both in terms of collaboration and cohesion. The individuals took advantage of teamwork to maximise their learning potential and let it impact their teaching. Thus, in this study, teachers changed with respect to their knowledge of their respective subject areas and their use of teamwork in curriculum design.

The findings in this study also have implications for teacher professional development in polytechnics and other educational institutions in Ghana, as well as in other developing countries. By employing the IMPG for an analytical look into the components of design activities by teachers, empirical grounding has been offered for the intertwined changes in individual teacher knowledge and the sensitivity of these changes to the complex interactions with content and teaching. Similarly, polytechnics in developing countries may need to consider assessing teacher change in terms of professional growth to discover teachers' idiosyncratic and personal development in all avenues of their profession, thereby acknowledging the situated and personal nature of teacher practice.

References

- Alexander, P. A. (2007). Bridging cognition and socioculturalism within conceptual change research: Unnecessary foray or unachievable feat? *Educational Psychologist*, 42, 67–73.
- Alexander, P. A., Schallert, D. L., & Reynolds, R. E. (2009). What is learning anyway? A topographical perspective considered. *Educational Psychologist*, 44, 176–192.
- Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012a). Professional development needs of polytechnic lecturers in a curriculum reform scenario. *International Journal of Training and Development*, 16(1), 67–76. <https://doi.org/10.1111/j.1468-2419.2011.00389.x>
- Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012b). Updating polytechnic teachers' knowledge and skills through teacher design teams in Ghana. *Professional Development in Education*, 38(1), 7–24.
- Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012c). Advancing perspectives of sustainability and large-scale implementation of design teams in Ghana's polytechnics: Issues and opportunities. *International Journal of Educational Development*, 32(6), 787–796.
- Billett, S. (2009). Personal epistemologies, work and learning. *Educational Research Review*, 4, 210–219.
- Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, 33(8), 3–15.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32–41.
- Burrell, A. R., Cavanagh, M., Young, S., & Carter, H. (2015). Team-based curriculum design as an agent of change. *Teaching in Higher Education*, 20(8), 753–766. <https://doi.org/10.1080/13562517.2015.1085856>
- Clandinin, J., & Connelly, F. (1992). Teacher as curriculum maker. In P. Jackson (Ed.), *Handbook of research on curriculum* (pp. 363–401). New York: Macmillan.
- Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, 18, 947–967.
- Coenders, F., Terlouw, C., Dijkstra, S., & Pieters, J. (2010). The effects of the design and development of a chemistry curriculum reform on teachers' professional growth: A case study. *Journal of Science Teacher Education*, 21(5), 535–557.
- Deketelaere, A., & Kelchtermans, G. (1996). Collaborative curriculum development: An encounter of different professional knowledge systems. *Teachers and Teaching: Theory and Practice*, 2(1), 71–85.

- Desimone, L. M. (2011). A primer on effective professional development [Editorial material]. *Phi Delta Kappan*, 92(6), 68–71.
- Eraut, M. (2007). Learning from other people in the workplace. *Oxford Review of Education*, 33(4), 403–422.
- Gallagher, K. L., & Ford, K. J. (2002). 90 minutes a day aims to create a new culture. *Journal of Staff Development*, 23(4), 65–68.
- Gervedink Nijhuis, C., Bakah, M. A. B., & Akomaning, E. (2009). Leadership challenges involved in managing institutional and curriculum changes in polytechnics. In W. Kouwenhoven, G. Oduro, & K. Nsiah-Gyabaah (Eds.), *Trends in polytechnic education in Ghana* (pp. 85–100). Amsterdam: Vrije Universiteit.
- Gervedink Nijhuis, C. J., Pieters, J. M., & Voogt, J. M. (2013). Influence of culture on curriculum development in Ghana: An undervalued factor? *Journal of Curriculum Studies*, 45(2), 225–250.
- Glazer, E. M., & Hannafin, M. J. (2006). The collaborative apprenticeship model: Situated professional development within school settings. *Teaching and Teacher Education*, 22, 179–193.
- Greeno, J. G. (2003). Situative research relevant to standards for school mathematics. In J. Kilpatrick, W. G. Martin, & D. Schifter (Eds.), *A research companion to principles and standards for school mathematics* (pp. 304–332). Reston, VA: National Council of Teachers of Mathematics.
- Greeno, J. G., Collins, A. M., & Resnick, L. B. (1996). Cognition and learning. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 15–46). New York: Macmillan.
- Greeno, J. G., & van de Sande, C. (2007). Perspectival understanding of conceptions and conceptual growth in interaction. *Educational Psychologist*, 42, 9–23.
- Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record*, 103(6), 942–1012.
- Handelzalts, A. (2009). *Collaborative curriculum development in teacher design teams*. (Doctoral thesis). Enschede, The Netherlands: University of Twente.
- Hoekstra, A., Beijgaard, D., Brekelmans, M., & Korthagen, F. (2007). Experienced teachers' informal learning from classroom teaching. *Teachers and Teaching, Theory and Practice*, 13(2), 189–206.
- Hofstede, G. H. (1980). *Culture's consequences: International differences in work-related values*. Beverly Hills, CA: Sage.
- Hord, S. (2004). *Learning together, leading together: Changing schools through professional learning communities*. New York: Teachers College Press.
- Little, J. W. (2003). Inside teacher community: Representations of classroom practice. *Teachers College Record*, 105(6), 913–945.
- Loveder, P. (2005). *World trends in staff development: Implications on the performance of technical education institutions*. Paper presented to the National Seminar on the Development of Technology and Technical–Vocational Education and Training in an Era of Globalization.
- Miles, M. B., & Huberman, A. M. (1994). *An expanded source book: Qualitative data analysis* (2nd ed.). London: Sage Publications.
- Millar, R., Leach, J., Osborne, J., & Ratcliffe, M. (2006). *Improving subject teaching: Lessons from research in science education*. London: Routledge Falmer.
- Neuendorf, K. A. (2002). *The content analysis guidebook*. Thousand Oaks, CA: Sage.
- Nieveen, N., Handelzalts, A., Van den Akker, J. J. H., Homminga, S. (2005). *Teacher design teams: A scenario for school-based curriculum innovation*. Paper presented at the European Conference on Educational Research.
- Nsiah-Gyabaah, K. (2005). *Polytechnic education in Ghana: The past, the present and the future*. Paper presented at the Kick-off Conference: NPT/ UCC Project on Building Management and Leadership Capacity in Polytechnics, Cape Coast, Ghana.

- Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal*, 44(4), 921–958.
- Penuel, W. R., Riel, M., Krause, A. E., & Frank, K. A. (2009). Analyzing teachers' professional interactions in a school as social capital: A social network approach. *Teachers College Record*, 111(1), 124–163.
- Peressini, D., Borko, H., Romagnano, L., Knuth, E., & Willis, C. (2004). A conceptual framework for learning to teach secondary mathematics: A situative perspective. *Educational Studies in Mathematics*, 56, 67–96.
- Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, 29(1), 4–15.
- Resnick, L. B. (1987). Learning in school and out. *Educational Researcher*, 16(9), 13–20.
- Schön, D. A. (1987). *Educating the reflective practitioner: Towards a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.
- Simmie, G. M. (2007). Teacher design teams (TDTs) – building capacity for innovation, learning and curriculum implementation in the continuing professional development of in-career teachers. *Irish Educational Studies*, 26(2), 163–176.
- Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review*, 3, 130–154.
- Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., et al. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education*, 27, 1235–1244.
- Wenger, E. (2003). *Communities of practice: Learning, meaning, and identity* (2nd ed.). Cambridge, UK: Cambridge University Press.
- Yin, R. K. (2003). *Case study research design and methods* (3rd ed.). London: SAGE Publications.

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