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Chapter 6

Summary and Discussion
6.1 Summary and conclusions

The aim of this thesis was to clarify the relation between teacher knowledge and the decisions they make while designing innovative lessons, in order to be able to effectively support teacher professional development in the context of curriculum reform. The following two research questions were central to our studies:

1. What decisions do biology teachers make when designing context-based lessons for their own classroom practice, and how do these relate to their practical knowledge? (chapters 2, 3 and 4)
2. What are characteristics of an effective professional development strategy to support biology teachers when they design context-based lessons for their own classroom practice? (chapter 5)

In chapter two, we used a combination of thinking aloud protocols, interviews and classroom observations to gain a better understanding of the decisions biology teachers take when designing context-based lessons for their own classroom practice. We built on the idea that teachers, when designing lessons, use rules-of-thumb: notions of what a lesson should look like if certain classroom outcomes are to be reached. For the purposes of this study, we operationalised our first main research question into the following two more specific questions: (1) What rules-of-thumb do biology teachers use when designing context-based lessons for their own educational practice? And (2) How do these personal rules-of-thumb relate to the formal innovative goals and lesson characteristics? Six secondary school biology teachers with varying backgrounds were asked to design and implement lessons for their own classroom practice, while thinking aloud. We observed their lessons and interviewed the teachers prior to and after the lessons. Our results suggest teachers’ personal rules-of-thumb do indeed guide the decisions teachers make. These rules-of-thumb were often strongly associated with intended lesson outcomes, such as having fun, having students understand the relevance of biological concepts, or triggering preconceptions. While all teachers said on beforehand they intended to faithfully apply the reform criteria in their design, it was only during the design of their lessons that the dominant role of teachers’ personal rules-of-thumb came to light. Those personal rules-of-thumb appeared to have more impact on the lesson design than formal innovative goals and criteria. For instance, while according to the formal principles, the use of real-life situations (contexts) in class is thought to increase relevance, student understanding, coherence and student motivation, according to most teachers a context which was too specific and realistic would not motivate students to learn and would decrease the relevance of the curriculum in the eyes of the students. We propose that a teacher’s personal rules-of-thumb can be viewed as that part of
the teacher’s practical knowledge that has a direct effect on educational decision-making, and that they are equivalent to heuristics people in diverse settings are shown to use to find solutions in circumstances when time and means are constrained (Gigerenzer, 2008).

In chapter three, the relation between teacher’s practical knowledge and their design decisions was further explored. This chapter was written in the form of a review of Donald Schön’s *The Reflective Practitioner* (1983), and asked the question how Schön’s concept of reflective practice could be used to relate a teacher’s practical knowledge to his design decisions. Schön describes the process of reflection-in-action as essentially a design process in which knowledge-in-action is applied, tested, and developed. During the process, a practitioner’s knowledge takes the form of *rules*, *types* (images of past situations, that help to recognize and understand the current situation), and *appreciative systems* (which determine how a practitioner assesses expected outcomes of design moves). We used these concepts to analyse the lesson design process of Richard, one of the teachers who took part in the study described in chapter two. Richard, an experienced biology teacher, designed a context-based lesson for his own students while thinking aloud. Richard’s case showed how his knowledge-in-action became activated and transformed during reflection-in-action while preparing his lesson. Framing Richard’s decision process as a process of reflection-in-action clarified the relation between his knowledge and his design of this lesson. This perspective helps to understand why teachers, in general, and Richard in particular, tend not to implement innovations in the exact way they were envisioned. We identified rules, types and appreciations, as active entities of Richard’s knowledge. Types could be fragments of former lessons, for instance, a lesson in which he used an appealing example to explain a specific biological concept. Both rules and appreciations and rules and types appeared to be closely related. One rule (“the lesson should help students to experience the beauty of biology when their body works as it should”), for instance, steered Richard’s appreciation of the idea to use a medical context. Further analysis also revealed that Richard’s rules were hierarchically related, and that decision-making during the design of his lesson could be represented as a trajectory through his personal hierarchical system of rules and goals. Goals that are higher in the hierarchical system give a new meaning to Schön’s concept of “appreciative systems”, a concept which in Schön’s book was rather vaguely defined. Therefore, we postulate that the use of hierarchical goal systems could add to Schön’s understandings of reflective practice by understanding better how rules, types, and appreciations influence decision-making and are interrelated.

In chapter four we further elaborated on the use of hierarchical goal systems to understand teachers’ interpretation and implementation of an innovative curriculum. A goal system is defined as a mental representation of the goals that are activated in a given context for a certain individual, including the hierarchical means-ends relations between the goals, with very general goals, such as “good examination results” giving rise to more
specific goals like “students develop their logical reasoning skills” and behaviours such as “ask many open questions during practical work”. The study was situated in a professional development program for biology teachers who wished to learn to design context-based lessons for their own classroom practice. Twelve biology teachers participated. During an intake interview, each teacher’s individual goal system was co-constructed by means of the laddering method. We used interview data, lesson plans and thinking aloud protocols to gain insight into teachers’ interpretation and implementation of this educational innovation during the course of the program. We found that within a goal system, teachers’ core goals – which are defined as goals with two or more links to either higher or lower ranking goals – were strongly related to teachers’ interpretation and implementation of the reform ideas. To a slightly lesser extent, negative links – i.e. goals that obstruct or contradict each other- also appeared relevant and might be interesting targets for professional development activities. We conclude that goal systems form a valuable addition to existing instruments in the field as they seem to represent those parts of a teacher’s knowledge that genuinely influence decision-making processes in the context of reform.

In summary, chapters two, three and four provided the following answers to the first research question: teachers base their design decisions to a large extent on personal rules-of-thumb, which are associated with personal goals. Teachers’ personal rules and goals are hierarchically related, and can be represented in the form of a goal system. A goal system represents that part of a teacher’s practical knowledge that is directly related to the decisions this teachers makes when planning for teaching.

Chapter five aimed to answer the second main research question. It reported on the development and evaluation of a professional development strategy that aimed at supporting biology teachers’ design of innovative context-based lessons for their own students. We proposed that such a professional development program would need to have the following characteristics: (1) knowing that teachers’ own goals and rules largely determine their interpretation of a reform, the program should build upon teachers’ existing systems of rules and goals. Also, knowing that designing context-based lessons is complex, the program should offer (2) specific support in the form of design tools and heuristics, combined with (3) examples and modelling activities to help teachers to envision reform practices. The study was carried out parallel to the study that was reported in chapter 4, and was situated within the same professional development program, in which twelve biology teachers participated. All teachers designed several (series of) context-based lessons, the majority of which centred around a context which was a concrete situation from students’ life worlds or from professional or scientific practices. Also, most lessons focused on key concepts of biology. The implementation of other reform criteria, such as using activities that match the context or including de- and recontextualisation activities,
varied considerably among the teachers and the individual lessons they designed. Activities that involved explicit reflection on goals or the formulation of intentions were not perceived as useful by most teachers, most probably because teachers’ knowledge and beliefs are largely tacit, and are closely linked to their actions. The study supported findings by former studies that teachers do not use design tools in the form of fixed roadmaps or forms. Design tools in the form of heuristics, however, were readily adopted, especially when these were vividly modelled by teacher educators, or used during personal coaching. Another effective approach was offering reform elements to bring solutions to problems of practice during moments of individual coaching, while attending to the teachers’ own goals. The highest impact, however, had the examples that were used, either during modelling activities or during group discussions. These types of design support align with the way teachers take their decisions while designing lessons, knowing that this process is largely guided by these teachers’ personal goals and rules-of-thumb (chapters 2 and 4) and their knowledge of specific cases (chapter 3). We therefore recommend researchers and teacher educators to develop and use prototypical lessons that capture valued educational principles, such as the ones prescribed by the context-based reform, combined with the heuristics that are needed to design such lessons.

6.2 Discussion

In the introduction of this thesis, we sketched an overview of recent history and current thinking about teacher learning, teacher thinking, and the relations between teachers’ personal practical knowledge and curriculum reform. Two main problems were identified. The first problem related to our lack of understanding about the relation between teachers’ knowledge and their actions. The second was that although we have an idea of many general factors influencing teacher learning, we need better theories about how to support teachers when they develop their practical knowledge within the context of curriculum reform. Concerning the first main problem we decided to focus on the relation between teacher knowledge and the decisions they take when designing lessons. During our studies, we partly reverted to perspectives and research methods that were in vogue before the research of teaching turned to the role of knowledge in teaching in the 1980s, such as studying decision-making processes using thinking aloud protocols, and we combined this with insights from other research fields, such as goal system theory and design studies. The results show that goal systems enable one to efficiently and validly represent the relation between teachers’ personal practical knowledge and the decisions they make while designing lessons. The professional development study (chapter five) indicates that in order to effectively support teachers in their design of innovative lessons, the types of design support that are offered
should be congruent with the nature of teachers’ design processes and the manner in which their knowledge informs their design decisions. Below, we will discuss how the outcomes of our studies contribute both to current research into teachers’ cognitions and their actions and to the development of effective professional development practices.

6.2.1 Goal systems help to understand teacher decision making while designing lessons

Although everybody would agree that there must be a connection between what teachers know and believe and what they do, many studies have found cognitions and actions to be poorly related. Fives and Buehl (2012) list a number of reasons for this incongruence between teachers’ cognitions and actions, the most important of which is that many studies focus on higher order goals, but disregard other beliefs that more strongly guide the decisions teachers take, such as whether a teacher believes that he/she is able to successfully implement a given strategy within a given context with limited resources. Also, some studies suffer from methodological problems, for instance when they rely purely on teachers’ self-reports, both when describing their cognitions and their practice. As we have seen in chapter 2 of this thesis, in interviews teachers might testify that they wish and intend to implement a certain educational idea, however, during the translation into action previously hidden but more powerful cognitions might redirect these intentions.

The study of teachers’ decision-making processes while thinking aloud, which is reported in chapter 2, indicated the importance of rules-of-thumb as the steering entities of teachers’ knowledge, that come into action while teachers design their lessons. During the process of lesson design, teachers’ rules and goals, that are at other times largely tacit, become active, and when these conflict with reform goals, teachers’ existing rules and goals typically determine the direction the design process takes. We were certainly not the first to identify the importance of rules in teachers’ decision-making processes, nor to recognize the fact that rules are strongly linked to intended outcomes (Berliner, 1986; Elbaz, 1983; Feldman, 2000; Leinhardt & Greeno, 1986; Peters & Beijaard, 1983). Others have also found before that while educational reformers are often concerned with only one goal, promoting student learning, teachers have many additional concerns, such as maintaining lesson momentum, creating positive emotions, and meeting personal needs (Doyle & Ponder, 1977; Kennedy, 2002). So, what do the studies in this thesis add to those understandings?

First, the case-studies in chapter 2 thesis gave an impression of how teachers’ rules and goals are hierarchically related. This idea was further developed in chapter 3, where Richard’s case showed, for instance, how his rule to use an appealing context in which the body functions as it should, is linked to his intended outcome to have students understand the beauty of the complexity of the body when it functions normally, which in turn should lead to students having a positive image of biology. In chapter 4, we combined this understanding
of the importance of teachers’ rules and goals with the insights from self-regulation theory and goal systems thinking (Carver & Scheier, 2001; Ford, 1992; Kruglanski et al., 2013; Shah & Kruglanski, 2008), and showed that teachers’ rules and goals and their hierarchical relations can be efficiently and effectively elicited by means of a laddering interview. The findings demonstrated that each teacher’s goals, and most notably teachers’ core goals, define teachers’ interpretation of reform ideas, and are closely connected to the decisions teachers make when designing lessons. The findings from this study have since then been confirmed by others. Westbroek, Janssen & Doyle (2017) demonstrated, for instance, how three highly qualified chemistry teachers’ core goals determined their interpretation of a context-based chemistry approach.

Goal systems have important conceptual and methodological advantages as compared to other methods to elicit and represent teacher’s cognitions. First, a goal system does not discriminate between different kinds of goals, and therefore it does not one-sidedly stress goals related to student learning while disregarding goals related to one of the other concerns teachers might have. Second, cognitions and contextual demands are integrated in one hierarchical conceptual system of rules and goals. A teacher’s personal knowledge and beliefs, combined with contextual factors, determine which goals are selected and which means are available and will lead to the selected goals. Third, as already mentioned, goal systems make hierarchical relations between goals and means explicit instead of focusing on isolated teaching strategies or purposes for teaching. The strength of these hierarchical relations can be expressed in terms of a goal system’s horizontal and vertical coherence (Sheldon & Kasser, 1995). A system is said to be vertically coherent when higher and lower goals are strongly related, that is, when a teacher has the means to achieve his or her valued higher goals. Also, when making decisions, teachers will generally strive for horizontal coherence, that is, they will choose activities that will lead to the achievement of various goals simultaneously. The fragment of the goal system of Marion (chapter 4), who in this particular class frequently held classroom conversations, shows how this central activity relates to the goals she has for this particular class (figure 6.1), while her entire goal system showed that she used multiple teaching strategies to activate and motivate her students, one of her core goals. From a methodological perspective, the main benefit of using goal systems is that a goal system only depicts those goals that are actually related to the decisions teachers take when designing lessons, whereas other methods may yield goals that teachers find important, but are not directly related to the decisions they make. Another important advantage is its practicality: a goal system can be constructed during a laddering interview of less than an hour, without the need of recording and analysing lots of lessons and interview data.

For all the reasons summarized above, goal systems thinking might be one of the keys to the development of better targeted support strategies for teachers, which is the topic of the next paragraph.
6.2.2 Using goal systems, examples and heuristics to support innovative lesson design by teachers

As we explained in chapter 5, although we know that professional development activities occasionally have a substantial impact on teacher thinking and teaching practices, well-developed theories about teacher learning are lacking (Kennedy, 2016). In other words, sometimes PD projects are effective, sometimes they are not, and we do not know exactly how to explain that, apart from the influence of general features such as facilitating cooperation between teachers and making connections with classroom practices (Borko et al., 2010; Van Veen et al., 2010). There is a need for more specific guidelines how to support teachers when they integrate reform ideas in their existing practice.

A first step is the recognition that teachers’ existing knowledge and beliefs will determine their response to reform proposals and professional development activities. Our studies showed that goal systems can be used to predict how teachers will respond to a reform proposal, by considering how such a proposal relates to a teacher’s (core) goals. Next, the teacher should be supported in translating reform ideas into goals and teaching strategies that are practical and congruent with their perceptions of their own situations.
The findings in chapter five showed that examples, in particular when vividly modelled, and heuristics might be the most effective kinds of design support for teachers who design innovative lessons for their own classroom practice. Both heuristics and examples are congruent with the manner in which teachers’ practical knowledge influences decision-making when designing lessons. First, we have seen that teachers’ decisions are in important ways the result of the application of rules-of-thumb, many of which have heuristic value; a heuristic being defined as “a strategy that ignores part of the information, with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods” (Gigerenzer & Gaissmaier, 2011). The rule, for example, for William to “use the same order as the book when explaining new content, except when this order is illogical” allows him to quickly decide on the structure of his teaching, just like the rule “use mini-assignments when explaining new content” allows Nicoline to activate students within a traditional lesson structure. The heuristics that were offered during the professional development program (chapter five), such as “use an existing stimulating context and move it from the end to the beginning of the lesson” and “show a newspaper heading and ask students an open question to discuss in groups” can have, in the teachers’ minds, similar function as their existing rules or heuristics, while quickly resulting into lessons that are more aligned with the proposed context-based approach. Second, many studies that are performed under the umbrella of “naturalistic decision making” (e.g. Klein, 2008) and design studies (e.g. Schön, 1988) have shown that case-based reasoning seems to be the preferred method of reasoning for most people when planning for action. Likewise, when teachers design their lessons, cases or examples of former lessons, or lessons given by others, are essential to analyse given situations, generate new ideas (Schön, 1988; Shulman, 1986a) and to make mental images of the kind of lessons the teacher is designing (Kennedy, 2006). One explanation for the inspirational power of cases is, that cases, having proven their worth in real-world settings, offer solutions for many different problems simultaneously, such as maintaining lesson flow, engaging students and preparing the lesson with easily available materials, and that adapting a given example can be done easier and faster than designing an entire new one. Another explanation might be, that cases are stored as episodic memory, as opposed to more abstract criteria and design models, which are stored as semantic memory (Lawson, 2004). Therefore, cases are easily retrieved from memory and used during creative processes such as lesson design. This might also be the reason that, in our study, vividly modelling examples had a far larger effect than studying exemplar materials on paper.

Although heuristics and cases might now seem two separate entities, in reality, heuristics and cases are closely linked, especially when a heuristic leads to the basic outline of an entire lesson. One case that was designed and discussed by one of the teachers from chapter five, and that functioned as a source of inspiration for other teachers, for example, was a lesson in which students conducted several short experiments, asking themselves the same central
question over again. Such a lesson can be designed using the heuristic “provide students with a number of cases and one central question to apply to each case”. In design studies, it has been described how the activation of a case in a designer’s mind often automatically involves certain design moves that quickly lead to a first idea for the design, often implying the use of a heuristic (Boling, 2010). A second way in which cases and heuristics are related is when people use a heuristic to adapt existing cases, for instance, when a teacher applies the reverse heuristic to adapt an existing lesson.

6.3 Limitations

Inevitably, the studies reported in this thesis have their limitations, three of which are: (1) a somewhat unnatural approach of the design process, (2) a focus on lesson design, disregarding enactment and (3) limitations to the evaluation and redesign of the professional development strategy.

In the first study, the design process was approached as if the process happened in maximum one hour, and as if the lesson plan was the end product. In reality, the design process can be regarded as an ongoing cycle of planning, enactment, and reflection (Yinger & Hendricks-Lee, 1994). Many teachers are constantly aware of possible leads for a lesson. They collect newspaper articles and stories, they get new ideas during a walk through the woods or during discussion with colleagues. New lesson ideas are often tried out tentatively, and further developed over several lessons. Also, teachers often do not plan per lesson, but rather plan for longer periods of time ahead. The thinking aloud instrument does not seem to comply with this natural process of designing lessons. Still, the rules and goals the teachers used during their thinking aloud processes, were, according to the teachers themselves, representative for their regular way of thinking. Also, no large deviances were found between the lesson process, lesson plan and actual implementation of the lesson, which might mean that the thinking aloud task gave a good approximation of the thought processes that influence the teachers’ decision-making under natural circumstances.

Another limitation was the disregard for lesson enactment. The studies were mainly focused on the lesson design processes, for all the reasons we summarized before, and less on lesson implementation and evaluation. When we studied the implementation of the lessons, we focused on content and order of the activities, while other aspects of the interactions between teachers and students were mainly left out of consideration. Also, although we asked and encouraged the teachers to measure the effects of their teaching, we did not measure the quality of the teaching and learning processes in terms of learning outcomes. We have demonstrated how the decisions teachers take are informed by their goal systems, and how this might differ from what teachers say in interviews. Follow-up
studies are needed to see whether and how goal systems are predictive of teachers’ actions in class.

A third important limitation, specifically related to the development of the professional development strategy (chapter 5) was that while the separate ingredients of the professional development strategy were tested in several previous settings, including professional development projects and teacher education courses the entire professional development strategy was tested in only one cycle of development and evaluation. Ideally, more cycles of redesign and evaluation would follow, with new groups of participants. A related issue is, that the studies reported in chapters 4 and 5 were conducted simultaneously, using the same data. For that reason, it was not possible to benefit fully from the insights from chapter 4 when developing the professional development strategy.

6.4 Implications for teacher education, policy and further research

6.4.1 How can we link goal systems to other conceptualizations of teacher knowledge?
It was beyond the scope of this thesis to study possible links between goal systems and existing conceptualizations of the knowledge of teachers, such as Shulman’s influential categorization of teacher knowledge into seven different types of knowledge (content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge (PCK), knowledge of learners and their characteristics, knowledge of educational contexts and knowledge of educational ends, purposes and values) (Shulman, 1987). The studies in this thesis, however, offer leads to bring together the goal system construct with such knowledge constructs. One might ask, for instance, what is the source of different goals within a goal system; whether a certain goal might be derived from experience, from scientific evidence or from reform ideals. Also, when studying the thinking-aloud protocols, we have seen that some teachers activate topic-specific knowledge about learning difficulties, curriculum standards and possible teaching strategies, which clearly links to their PCK, while others seem to have more general and topic-independent solution strategies. While in this thesis we only studied teachers’ goal systems that are valid for their general teaching practice in one particular class, in reality, goal systems can be elicited at different levels of specificity. The following example clarifies how such goal systems of varying specificity might relate to each other. Clara, one of the teachers who participated in the professional development program described in chapters 4 and 5, but who had to quit halfway because of personal circumstances, told us about a lesson in which she asked her students to draw a peanut. Figure 6.2 represents a small part of her goal system, in which she links her decision to use a peanut to several goals. As one can see, in this case, the higher one comes in the goal system, the more general her goals are. Many goals relate to her goal, to invoke a sense of wonder
Students draw shelling peanuts

Practical: use cheap materials that are readily available

Peanuts have funny life cycles

Everybody knows peanuts, which makes extra surprising that there is a baby plant in it

You need to observe it very well before you can realize what’s special about it

Figure 6.2 A fragment of Clara’s goal system about her teaching strategy about plant life cycles, using peanuts

Activate students

Motivate students

Students learn that they are capable of coming up with a lot of ideas themselves already

Curiosity

Students feel satisfied

Force myself to slow down

Students realise they learnt something

Check student understanding

End lesson by asking the same question again, or ask what was new

Start lesson by asking open questions

Write students’ answers on the board

Overview for students

Allow students to follow the lesson

Students realise they learnt something

Check student understanding

End lesson by asking the same question again, or ask what was new

Start lesson by asking open questions

Write students’ answers on the board

Overview for students

Allow students to follow the lesson

Students realise they learnt something

Check student understanding

End lesson by asking the same question again, or ask what was new

Figure 6.3 A goal system showing Clara’s goals concerning the beginning and ending of lessons in grade 1
in her students. When asked for more examples, Clara will name more instances in which she uses recognizable objects in class to enhance students’ sense of wonder, and bringing about this sense of wonder will prove to be a core goal in Clara’s general practice. There are also instances, however, when both lower and higher goals are quite topic-specific. When a lesson is about sexuality, for example, a higher goal might be “students know how to set healthy relationship boundaries”, while in a lesson about genetics, a goal might be “students can make informed decisions in contexts of genetic testing”. In our studies, we have chosen to focus slightly more general goal systems that are topic-independent, but specifically valid for a certain group of students, because we wanted the goal system to be predictive of the decisions teachers take when designing lessons of all kinds of topics for this particular group of students. If one is interested in studying the relation between teachers’ PCK and their actual teaching practice regarding specific topics, however, one might choose to make more topic-specific goal systems, such as Clara’s plant life cycle goal system.

Instead of focusing on specific topics, one might also focus on more general teaching practices when constructing goal systems, as another example from Clara’s will demonstrate. Figure 6.3 shows what Clara does when starting and ending lessons in grade 1 (age 12/13), and why she does it. These episodes are directed at motivating and activating her students through constructivist activities (figure 6.3). Such goal systems might be used in research and educational settings to clarify and demonstrate teachers’ practical knowledge as related to common practices (often called “core practices”), such as starting and ending lessons, guiding classroom discussions, or explaining new content.

6.4.2 Using goal systems for research and practice in teacher education and professional development

The findings in chapter 5 show that for in-service teachers, goal system construction appears to be effective and predictive of future decision-making when designing lessons, while the teachers experienced it as a meaningful activity. These findings show the potential for goal systems as reflective and diagnostic instruments in teacher education and professional development settings. One’s work satisfaction depends on the extent to which somebody succeeds in reaching one’s goals, which can be related to student learning, but just as well to having fun, having a good relationship with students, developing oneself, etcetera. A goal system integrates all such goals, in so far as these are related to someone’s actions, and might also include goals that are aspired, but are, according to the teacher, not yet satisfactorily met. Negative links between goals might also bring sources of frustration to the light, in that they show how some goals and actions might hinder the accomplishment of other goals.

In recent studies employing the so-called “bridging strategy” goal systems are used as a starting points for personal professional development trajectories (Janssen, Grossman, & Westbroek, 2015; Janssen et al., 2013) in which teachers are supported to step-wise alter
their practice in such a way that both their core goals and the reform goals are met. Janssen, Westbroek & Doyle (2014), for instance, successfully supported pre-service biology teachers to stepwise change their practice from performing cookbook labs to open inquiry by first analysing their goal systems and devising a support progression in which each step would mean an amelioration in the attention of teachers’ own goals. Westbroek, Van Rens & Van den Berg (2017) used a similar approach to support experienced teachers when they introduce formative assessment strategies in their teaching.

Further research into the usefulness of using goal systems in teacher education courses and professional development projects would be recommended. Possible research questions could refer to the relation between a student teachers’ goal system and the quality of their teaching practice, developments in the goal system during and after teacher education, the usefulness of combining goal system construction with learning new teaching strategies, etcetera. Preliminary results from our teacher education courses indicate that in general student teachers’ goals and actions are less well-connected than those of more experienced teachers, which is consistent with earlier findings from lesson planning studies that novice teachers plan for similar actions as expert teachers, but do not as clearly link it to multiple goals to be reached. Berliner, for example, found that both novice and expert teachers plan to do homework checks, but while the novice teachers saw this merely as a means to correct students’ answers, the expert teachers additionally considered it as an opportunity to collect student information on which to base further instruction (Berliner, 1986).

We would also be interested in developments in teachers’ systems of goals over longer periods of time. While in our study we found goal systems to remain quite stable over the course of one school year (chapter 4), one might expect the systems to change over time, when the context or a teacher’s knowledge, beliefs or ambitions change (Shah & Kruglanski, 2008). How does such a change process take place? Core goals would be expected be the most stable elements of the system, but based upon existing writings about self-regulation, one could additionally hypothesize that higher goals change only slowly, while lower goals trigger fast feedback and quick adaptations of behaviour or goals (Lord, Diefendorff, Schmidt, & Hall, 2010). This would mean that when a change in teaching practice has consequences for mid-level goals such as classroom order, or for the number of questions students ask in class, one would expect quick adaptation or continuation of the new behaviour, while it would take longer to develop higher level goals. Related questions are: what does it mean that some teachers have more complex goal systems than others? And what does it mean that some teachers tend to talk about their practice in higher level goals (“stimulate critical thinking”; “making learning visible”) while others talk predominantly in terms of lower level goals (“use short instructions”; “give an overview over the lesson on the whiteboard”)?
6.4.3 Developing and using a collection of examples and heuristics

Having learnt that the combination of examples, modelling and heuristics offer such powerful learning opportunities (chapter 5), we argue for building a collection of rich cases and heuristics. In literature, many inspirational cases can be found. Such examples, however, are not always readily available for teachers. The same goes for heuristics. Using heuristics in teacher education and professional development may give some the impression of downgrading theory, but the opposite is true: translating theory into heuristics means upgrading theory to enable it to be used in practice (Janssen et al., 2015). Apart from the more practical development of cases and heuristics, more research is needed into the actual use of cases and heuristics by teachers when designing their lessons. In our studies, it was not always possible to separate the effect of using examples and heuristics from the effect of modelling. Further study is needed to be able to compare the effects of vivid descriptions of someone’s design process, for instance, with and without modelling.

Finally, in the same way as the language of design studies have enriched and stimulated our research into teacher thinking and lesson design, this language has the potential to enrich teacher education courses. The image of the teacher as a designer appears to be a fruitful metaphor for use in teacher education. Modelling the use of heuristics, using vivid examples, feeds beginning teachers’ practical knowledge, just like a beginning architect would be both inspired and better equipped when experiencing many different buildings, combined with heuristics to create a similar effect as, say, a dome church or an English college library. In teacher education, we should inspire students to develop into adaptive experts, who simultaneously can recognize situations as familiar and use new situations as opportunities to experiment and develop their practical knowledge.

6.4.4 Implications for curriculum policy

Curriculum planners should not only recognize the fact that teachers have a multitude of goals to consider when planning their lessons, while their own innovation ideas are often focused on reaching one to a few overall goals. They could also go a step further and recognize the special wisdom that is enclosed in a teachers’ goal system, that special wisdom that a policy maker, without working in the teachers’ classroom context, could not have. This wisdom is largely implicit, and packaged in the form of rules, goals and cases instead of theories that can easily be transferred, but this does not mean that a teacher’s practical wisdom is less developed, less valid or less “wise” than a curriculum developer’s theory (van Driel et al., 2001). Instead of viewing reform ideas as packages of knowledge that should be implemented by teachers in order to innovate and improve teaching practices, it would be recommendable to strive for meaningful communication and mutual learning between teachers and policy makers, between teachers and researchers and between policy makers and researchers.