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TNO report

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How to coach teachers for professional development

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Contents

1 Introduction

1.1 Background

In diverse domains, it is a challenge for teachers to improve their skills and competencies in such a way that their lessons keep up with the changing, discipline- or society-originating, educational demands. In their professional practice, they have to integrate additional, adjusted or new curricula into their teaching activities now and then. These curricula may appeal to new knowledge and skills that require training tailored to the context and person (e.g., school policies and teacher's experience on curricula's topic) . So far, Information and Communication Technology (ICT) has becoming important to record, store and share lesson material and outcomes. The next step would be to support the teaching itself with an electronic coach (eCoach) that enhances teacher's individual competencies and skills, and that supports the planning and giving of lessons.

A case study was conducted for sexual education to acquire insight in the possibilities and constraints of eCoaches for the development of teacher's competencies and the support of the lessons (see TNO report "E-coaching on teacher's competencies and situated lessons: The example of sex education"). Sexual education seemed to be interesting, because it requires additional competencies compared to classical lessons that centre on school-custom content. We applied the iSelf Internet-tool for self-evaluation and learner feedback of a curriculum that was provided by Soa-Aids. iSelf aims at helping the learner to gain insight in his/her own development of *competencies* by self-directed learning (Stubbé et al, 2008; Theunissen et al, 2011). The iSelf was linked to the Soa-Aids website, but due to technical and organizational constraints insufficiently integrated so that constructive user experiences could not be acquired yet. For the same reason, new support functions for the (situated) teaching have not been implemented in the website and tested yet. One of the conclusions of this case study was that there should be a symbiosis of human and virtual coaching, in which tasks and responsibilities are shared. However, it is not known what tasks and responsibilities should be allocated to the eCoach or should remain to the human coach. In this study we explore coach functions and ways to decide what functions can be performed by an eCoach and what functions must stay with a human coach.

1.2 Study approach

This report present a literature study that aims at an overview of learning theories and related coaching techniques. It focuses on teacher professional development and online learning for adults. For this purpose, a framework of generic cognitive functions was specified to distinguish high level tasks of coaches and, subsequently, to determine the complexity of coach tasks. We argue that the complexity is an important factor in deciding about the allocation of tasks and functions either to electronic or human coaches.

1.3 Report structure

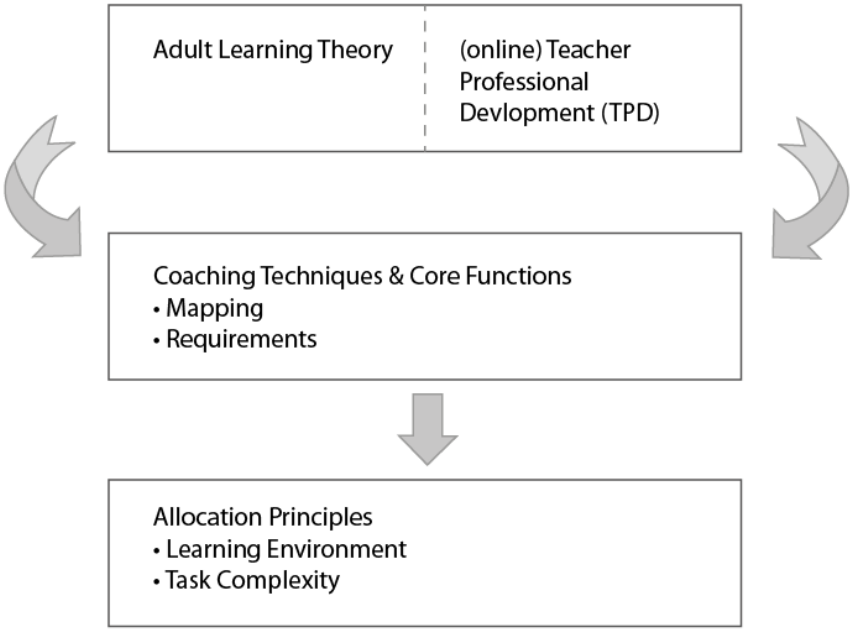

Figure 1 Paper structure.

Figure 1 shows the structure of this report. Chapter 2 describes the theoretical background of adult learning and the relation with coaching techniques.
Core features and coach functions in relation to teacher professional development are described in Chapter 3. In Chapter 4 coaching techniques are mapped on the core functions of professional development and translated to coach requirements. Chapter 5 discusses principles for allocating functions and tasks to eCoaches or real coaches based on the task complexity and learning environment. Chapter 6 contains the conclusions and discussion.

2 Adult Learning Theory

In this chapter we first describe educational philosophies related to adult learning. In the second paragraph five important learning theories are discussed. The third paragraph summarizes relevant coaching techniques and provides an overview of the techniques that are used within the learning theories.

2.1 Educational philosophies

The two major educational philosophies are the instructivist and constructivist approach. In the instructivist approach the instructor sets performance objectives and an approach to learning the content that is independent of the student. This approach is based on work from Skinner(1953) and, more recently, Merrill (2008). The constructivist approach, on the other hand, is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction rather than passively receiving information. This approach has its roots in work from Dewey (1966), Piaget (1973) and Vygotksy (1978, 1994). A third approach that has seen the light in more recent years is the connectivism approach (2012), this approach recognize that there is simply too much knowledge to take in – and it changes too quickly anyway. So forget about trying to "know" everything; instead, build your network of knowledge *sources*, and access them whenever you need them. These three approaches seem to be rather different, in theory. However, for implementation the right approach proves to be very much dependent on the specific learning goals and the specific characteristics of the students. Most of the time a mix of the approaches is used, and they overlap and complement each other as Tracey (2011) argues (Figure 2).

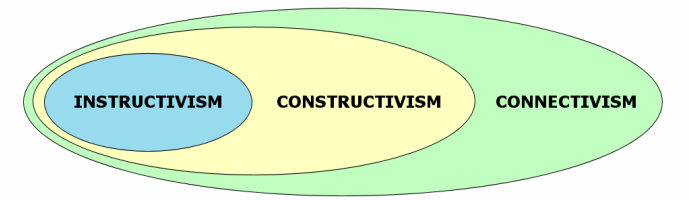

Figure 2 The three educational approaches of instructivism, constructivism and connectivism have a different scope.

Adult learning theories often take a constructivist base which is extended with some instructivism. Self-directed learning and critical reflection are strong principles, which are based in constructivism. On the other hand knowledge of facts and information (which is primarily gathered via direct instruction) is also seen as important in adult learning (The fourth Paragraph will describe the core feature of professional development programs).

2.2 Learning theories

In the domain of adult learning, the following learning theories are often used: andragogy (Knowles, 1980), experiential learning (Kolb and Frey, 1975), self-directed learning (Houle, 1961) and transformative learning (Mezirow, 1997). Other well-known learning theories are vicarious (observational or social) learning (Bandura, 1977) and Zone of Proximal Development (Vygotsky, 1978)

2.2.1 Andragogy

Andragogy is a learning model introduced by Malcolm Knowles in 1973 (Cercone, 2008). Andragogy is characterized by a learner-centered focus. The model distinguishes five assumptions of adult learners (Merriam, 2004):

1. *Self-Concept*: People move from dependency to self-directness. Adult learners have an independent self-concept and are able to direct their own learning.
2. *Experience*: Adult learners can use their acquired life experiences as a rich resource for learning (for themselves and others).
3. *Readiness*: The readiness to learn is related to the developmental phases people go through. For adult learners the readiness is closely related to the change they go through in social roles.
4. *Orientation*: Adult learners are problem-centered and want to apply new knowledge and skills immediately in daily life situation.
5. *Motivation* (Later added): As a person matures, he or she gets the motivation to learn from internal factors.

The assumptions contain underlying principles of other learning theories. For example, the second and third assumptions on experience and readiness are key aspects in experiential and transformational learning, and the first assumption on self-concept is in line with self-directed learning.

2.2.2 Experiential Learning

True experiences play an essential role in the experiential learning theory. Kolb (1975) proposed an experiential learning model which describes the learning process in four stages:

1. Concrete experience (putting it into practice).
2. Observations and reflection (objectively analyze the outcome).
3. Forming abstract concepts (reviewing your conceptual understanding).
4. Testing in new situations (experimenting to find solutions).

The stages are part of a continuous learning cycle. The learner can start his or her learning process at any stage and follow as many cycles as necessary.

2.2.3 Self-directed learning

According to self-directed learning, the learner is in control of his or her own learning process. All educational decisions like the initiation of learning, what to learn and how to achieve this are in the hands of the adult learner. This requires certain learner characteristics like independence, willingness to take initiative, persistence in learning, self-discipline, self-confidence and the desire to learn more (Cercone, 2008). Furthermore self-directed learning entails skills like goal-setting, planning, evaluation and reflection (Stubbé et al., 2008).

2.2.4 Transformative learning

Transformative learning finds its foundation in constructivism. Central in transformative learning is the cognitive learning process with key aspects as mental construction of experience, inner meaning and reflection (Merriam, 2004). The outcome and process of transformational learning is about a change in the way we see the world, by making sense of our experiences. Critical reflection is essential to undergo transformation and change once frame of reference (Cercone, 2008).

2.2.5 Vicarious (observational or social) learning

In social learning theories the interaction between people is central. Learning is based on observations of others in social settings. Bandura indicates the difference between observations and imitations, and states you can learn by observing without imitating. Learning by observing consists of four important processes:

1. Attention.
2. Retention (memory).
3. Behavioral rehearsal.
4. Motivation.

This theory underlies important concepts like motivational strategies, locus of control, social role acquisition and interaction with the physical environment and other learners (Bandura, 1977).

2.2.6 Zone of proximal development

The Zone of Proximal Development (ZPD) developed by Vygotsky (1978) is also a social learning theory. It describes the gap between what a learner can do on his/her own and with assistance. It originated in the analysis of child development. Children follow adult's example and by doing so gradually develop certain skills. As well as children adults can learn from collaborating with more capable peers. Furthermore scaffolding can be used to offer experiences within the learners ZPD.

2.3 Coaching techniques

Coaching techniques are techniques that coaches apply during teaching. A list of coaching techniques is provided below. The list is not exhaustive. It consists of clusters we made based on recurring recommendations, principles and characteristics found in literature (Carper et al., 2009, Cercone, 2008, Stubbe et al., 2008).

2.3.1 *Active participation*

In active participation the learner is actively involved in the learning process. It is important to encourage and support the learner to manage and monitor his or her own learning process. This embodies skills like goal-setting, planning, self-monitoring, self-instruction, self-assessment, problem solving and learning strategies. (Cercone, 2008, Characteristic 3 and 9, Stubbe et al., 2008, principle 1 and 2).

2.3.2 *Problem-centered*

Important characteristics of adult learners are that they have the need to know why they are learning something, they learn through doing, they are problem-solvers and learn best when the subject is of immediate use (Knowles, 1980). Real-life problems should be used as foundation for the learning experience. And allow the learner to practice and apply the learning in a real world setting (can also be virtual) in which the problem can be manipulated and different solutions can be tried out. (Cercone, 2008, Characteristic 8 and 10, Stubbe et al., 2008, principle 5)

2.3.3 *Collective participation*

Collaboration and dialogue can contribute to a meaningful learning experience. Therefore it is important to support social interaction with others, learners, and teachers/coaches and create a collaborative learning environment. A collaborative learning environment can provide role models to demonstrate behavior, social support, social comparison, but also offer the opportunity to help each other set goals, discuss how goals can be achieved, cooperate together in the learning process and ask for help. (Cercone, 2008, Characteristic 11 and 13, Stubbe et al., 2008, principle 4)

2.3.4 *(Self-) Reflection & building on prior experience*

Reflecting on performance and learning process by means of self-assessment and self-reflection provides the learner insight in his/her development. Furthermore self-reflection is necessary to connect new knowledge to prior experiences, and change personal attitudes and beliefs. (Cercone, 2008, Characteristic 5, 7 and 12, Stubbe et al., 2008, principle 3)

2.3.5 Scaffolding

Scaffolding can help learners to perform activities they are unable to perform without support. For example by assisting learners to complete complicated tasks by breaking them up in manageable sub-tasks with a clear beginning and end, providing examples, model demonstrative behavior, setting graded tasks etc.
It's important to also encourage and stimulate self-reliance. (Cercone, 2008, characteristic 4)

2.3.6 Support motivation to initiate, apply and persist learning program

The aim of learning programs is the development of competencies and bring about a change in attitude and behavior. Different adult learning theories underlie the importance of motivation for adult learners to initiate, apply and persist with the learning program. Fords Motivational Systems Theory encompasses the idea that motivation serves to direct, energize and regulate goal-directed activity (Ford, 1992, 3) According to Ford, people can be motivated by the facilitation of personal goals, emotional arousal processes, and personal agency beliefs. He established 17 motivational principles that contribute to this.

Some of these motivational principles are related to aspects of the coaching techniques already described above (e.g. the goal-setting process, goal-attainment, providing optimal challenges). Furthermore emotional arousal and personal agency beliefs contribute to effective decision making (Ford, 1992, p253). They incorporate considerations about consequences of courses of action in interaction with the environment (Ford, 1992, p. 253). Bandura also emphasizes the importance of self-efficacy (the belief in one's own ability to succeed in specific situations) in the initiation and persistence of behavior (Bandura, 1977). The learners willingness to engage in new experiences and apply changes in a certain context will be influenced by the anticipated of consequences and likelihood of success. Consequently, in order for learners to initiate, apply and persist the learning program, it is essential to support and facilitate motivational aspects.

2.3.7 Guide the learning process

Not so much a coaching technique, but just as important for a successful learning experience is the guidance of the learning process. The development of new skills goes through different stages e.g knowledge, practice and habituation. To facilitate the intended change of the learning program, it is important to support these different stages. For example, facilitating a safe practice environment simulating real world settings could contribute to the self-efficacy of the learner (see Section above).

Furthermore, research indicated that structural (e.g. contact hours, time span etc.) and process features (content and pedagogy) affect teachers knowledge, practice and efficacy (Carper et al., 2009). Important features (some already mentioned in previous coaching techniques), which contribute to the guidance of the learning process, are content-focus, active participation, self-reflection, sufficient feedback, evaluation and follow-up (Carper et al., 2009).

2.3.8 Mapping of coaching techniques and learning theories

Coaching techniques are not uniquely related to a specific learning theory.

Within different learning theories similar coaching techniques are used. Table 1 provides an overview of the coaching techniques and their (assumed) foundation in theory, based on Cercone (2008), Stubbe et al. (2008) and authors' own interpretation.

The support of motivation and guidance of the learning process are prerequisites for creating successful learning experiences, they are not related to a specific learning theory. Note that Table 1 intends to summarize the relevant research field for adult learning (theory *and* methods), as a starting point for deriving eCoach requirements.

Table 1 Coaching techniques and learning theories.

Learning Theories / Coaching Techniques	Andragogy	Experien-tial Learning	Self-directed learning	Transfor-mative learning	Vicarious (observa-tional or social) learning	Zone of Proximal Develop-ment
Active Participation (A)	X		X	X		
Problem-Centered.	X		X			
Collective participation	X	X	X		X	X
(Self-) Reflection & experience	X	X	X	X		
Scaffolding	X		X	X	X	X
Support motivation to initiate, apply and persist learning program	x					
Guide learning process	x					

2.3.9 Conclusion

There are many approaches and theories when it comes to adult learning. There is not one comprehensive theory, which unifies all adult learning factors, entails the complete set of coaching methods, and is applicable in every situation. Furthermore, people have their own preference in learning style and learning environments set specific constraints on the methods.

Although some theories accommodate such differences, a comprehensive, evidence-based and practical set of tailoring guidelines that can be applied for user modeling and personalization of eCoaching is lacking.
However, there is one fundamental principle in learning, which is change. Learning is about change, and to accommodate this you need to facilitate learning experiences that not only address the development of knowledge, skills and attitude, but also support the learners motivation to initiate, apply and persist the learning program and guide the learning process from knowledge and practice to habituation.

3 Teacher Professional Development

3.1 Core features of TPD

Chapter 2 described theories and coaching techniques for adult learning in general. In this study, we focus on a specific group of adult learners, namely professional teachers. Teachers need to have specific competencies and skills to cope with the individual needs of their students: A teacher must have an open attitude towards the students (**attitude**), feel confident enough (**self-efficacy**), know enough about the subject (**knowledge**), be able to explain it in different manners (**didactic skills**) and have the social skills to deal with different personalities (**pedagogical skills**) (Carper et al., 2009). There is a large variety of approaches to study these competencies and skills, and their effects on teaching performance, such as observation, interviews and surveys (cf. the diversity of educational theories and methods in Chapter 2). To elevate the quality of professional development studies, Desimone (2009) presents a conceptual framework for such studies, which encompasses measures and methodology for studying the effects of teachers' professional development on teachers and students. This framework is based on recent research knowledge and describes how the determinants—attitude, self-efficacy, knowledge, didactic and pedagogical skills—relate to the need for change in instruction by the teacher (with as ultimate goal improved student learning) and to core features and context aspects of teacher professional development (TPD). The model is shown in Figure 3.

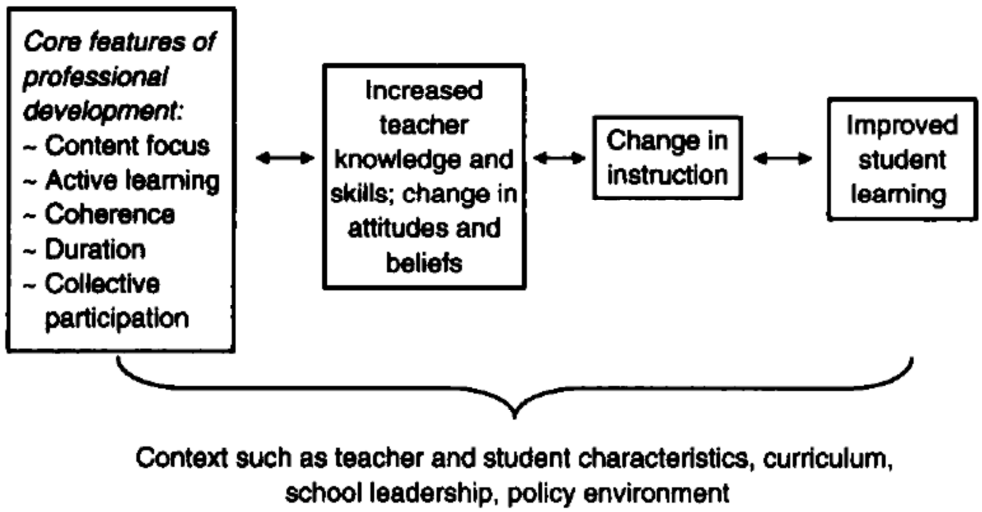

Figure 3 Core TPD features and their relation to teacher's competencies (knowledge, skills, attitudes and beliefs), instruction, student's learning and lesson context (Desimone, 2009).

In other words, the quality of programs for teaching the teacher depends on the presence of five core features: content focus, active learning, coherence, duration and collective participation. The features are premises for effectively increasing teachers knowledge and skills and change in attitudes and beliefs, leading to better instruction and improved student learning. The core features are described below (from Bhandari & Tech, in press).

Content focus concerns professional development that is designed to focus on activities concerning subject matter (e.g., biology, history, algebra) and content-specific pedagogy. It follows that professional development programs ought to be relevant for each specific teacher.

Active learning is the act of listening, learning, synthesizing and crystallizing information from an array of strategies. PD activities should promote and inspire active learning in the teacher. Researchers identify five strategies that supported active learning in PD (Desimone, 2009):
1) observations (trainer observes teacher or the teacher observes other teachers who became the school 'expert');
2) interactive and constructive feedback (learning what's right what works);
3) interactive discussions (learning from each other, sharing);
4) reviewing student work (looking for patterns);
5) initiating/leading discourse between teachers and teachers, and teachers and researchers. Like the students, teachers also want to enjoy what they learn, because it is learned better

Coherence is the third element of Desimone's framework and it is the understanding of federal/state PD statutes for school systems. These statutes first arrive in the human resource offices and the necessary administrators make the first wave of 'translations' to help their schools stay in compliance with the new plans. This 'translation' is put into language that school building administrators will be able to share with their teachers. With every new statute and plan, new ideas emerge to make the plan work. Those plans entail PD for teachers to meet the standards of the new legislation.

Duration is the fourth element and is time spent on PD. It begins when the need arises for PD and it is continued until the teacher can teach the PD content to another teacher. According to Desimone "sufficient duration" is the time spent on PD (number of hours or timespan) however long it takes to learn the innovation and be able to see the results if that innovation.

Collective participation is the interactive and constructive discourse between PD planners and participants. Collective participation is co-planning, co-teaching and partnering. Developing trust and partnerships between teachers and trainers/researchers is vital to collaborative participation. Building a sense of community where co-planning, co-teaching and partnering become practice is the ultimate goal to achieving collaborative participation among PD participants.

3.2 Core functions for online adult learning

Cercone (2008) discusses the implications of adult learning for online learning design. Cercones recommendations were used to define three clusters of core functions: core functions related to an *individual learner*, core functions related to a *group of learners* and core functions related to a *learning environment*.
Core functions related to the individual learner and group learners are prerequisites for coaches. Environment-related core functions are prerequisites for creating a productive learning environment. For these three clusters, we derived a set of core functions for an eCoach that supports Teacher's Professional Development and,

subsequently, identified for each function the relevant coaching techniques (CT) from the previous Chapter.

3.3 Core Functions related to individual learner:

Accommodate Personal Goals (CT: Active participation)
Allow the learner to set personal goals and adapt the teaching program accordingly. Provide manageable units of tasks with a difficulty degree that suits the individual learner and are in line with his/her goals. Monitor goal progress and review the goals regularly, adjust if necessary.

Accommodate Personal Experience (CT: Problem Centered, self-reflection & experience)
Allow the learner to build on prior experience by providing the opportunity to apply life and work experiences to the learning. Relate content and tasks to real-life situations.

Accommodate Real-life Situations and Problems (CT: Problem-centered)
Allow the learner to focus on personal challenges by relating content and tasks to real-life situations and problems, and providing relevant examples. Be specific about why content and tasks are relevant or important and link new information to what has been discussed earlier.

Provide Personalized Feedback (CT: Active participation, Problem-centered, Self-reflection & Experience, Scaffolding, Guide the Learning Process)
Provide the learner with personalized feedback about commitment (e.g., “You’re participating well in the discussion”) and progress (e.g., “since the last lesson you’re knowledge on x has increased significantly, you’re doing great”).

Support Personal Reflection (CT: Active-participation and Self-reflection & Experience)
Encourage the learner to reflect and challenge beliefs by providing reflective thinking techniques (e.g. by self-assessment, dilemmas, group discussions, reflective journals etc.)

3.3.1 Core Functions related to group of learners:

Support Group Discussion (CT: Collective participation)
Encourage learning from each other by facilitating peer-communities in which participants can share information, opinions and experiences and reflect on these.

Support Group Work (CT: Collective participation)
Encourage learning from each other by facilitating peer-learning groups in which participants can problem-solve together, work on group assignments and/or observe each other.

3.3.2 Core Functions related to learning environment:

Provide Flexibility (CT: Scaffolding, Support motivation, Guide the learning process)
Offer a flexible teaching program in which content (e.g. information and examples), tasks (e.g. assignments and techniques) and planning (e.g. sequence and pace) are adaptable to the personal needs of the learner.

Provide Regular interactions and sufficient available time (CT: Support motivation, guide the learning process)
Ensure regular interaction with the teaching program to achieve continuity. Attune to frequency of interaction and duration of the program to the learners needs.

Provide Sufficient Resources (CT: Guide the learning process)
Provide sufficient resources as well from within the organization (e.g. time, means and support are provided by organization) as from the professional development program; access to material to follow course and make assignments (e.g. literature, expert viewpoints).

Enable Trust (CT: Collective participation, Support motivation, guide the learning process)
Create trust in teacher, teaching program and participating peers.

Connect peers (CT: Collective participation)
Connect a diverse group of people with a common interest so they can learn from and with each other.

4 Functions and Requirements for Coaching

4.1 Introduction

Section 3.2 shows that most of the coaching techniques are represented in the core functions. However, the following techniques were not yet covered and will be added to the (refined) list of core functions:

- Scaffolding.
- Support motivation to initiate apply and persist TPD (incorporating motivational interviewing).
- Provide Safe Practice Environment.

The next Paragraph shows the refined list of core functions. The second column describes the requirement a coach should have to meet the core functions.

4.2 Requirements

The coach must have knowledge about the coaching techniques mentioned in the previous chapter and be able to apply them. Besides that, the demands of adult online learning environments require skills of the coach. Table 2 lists the skills that are needed to meet the demands.

Table 2 Core Functions and their requirements.

Core Functions	**Requirements**
Individual	
Accommodate Personal Goals	- Knowledge of learner goals - Reason about implications of learner goals on teaching program: - Adapt teaching program accordingly - Knowledge of learner performance - Measure deviation between learner goals and user performance - Provide feedback on learner performance and deviation between learner goals and user performance - Reason about implications of deviation between learner goals and learner performance: - Adapt teaching program and/or goals accordingly
Accommodate Personal Experience	- Knowledge of learner experience - Reason about implications of learner experience on teaching program: - Adapt teaching program accordingly.
Accommodate Personal Challenges	- Knowledge of learner problems - Reason about implications of learner problems on teaching program: - Adapt teaching program accordingly - Explain relevance of content and tasks
Provide Personalized Feedback	- Knowledge of learner personality - Reason about implications of learner personality

	on commitment and progress: - Adapt feedback accordingly - Knowledge of learner goals - Knowledge of learner performance - Knowledge of learner contributions - Measure deviation between learner goals and learner performance - Reason about implications of learner contribution to learner performance - Provide feedback on learner performance deviation between learner goals and user performance and learner contributions
Support Personal Reflection	- Knowledge of learner beliefs - Reason about implications of learner beliefs on teaching program - Adapt teaching program accordingly. - Encourage reflective thinking
Scaffolding	- Knowledge of learners next zone of development - Knowledge and application of situated scaffolding techniques - Adjust program by adding techniques - Evaluating the effect of scaffolds
Support motivation to initiate apply and persist TPD	- Knowledge of motivational techniques (this can be a large number of techniques with specific requirements. For conciseness reasons these will not be discussed here)
Group	
Support Group Discussion	- Facilitate group discussion - Encourage participation in group discussion - Summarize discussion - Reflect on discussion
Support Group Work	- Facilitate group work - Encourage participation in group work - ….
Environment	
Provide Flexibility	- Knowledge of learner needs - Knowledge of content - Knowledge of tasks - Knowledge of planning - Reason about implications of user needs on teaching program (content, tasks and planning): - Adapt teaching program accordingly - Inform and/or advise learner about adaptability of teaching program (flexible possibilities)
Provide Regular Interactions and sufficient available time	- Communicate moments of interaction - Create sufficient contact moments - Knowledge of learner goals - Knowledge of learner performance - Reasoning about required contact moments - Reasoning about required program length - Adapt teaching program accordingly (e.g. shorten,

	provide more examples) - Provide possibility of follow-up some time after program end
Provide Sufficient Resources	- Knowledge of learner needs - Meet needs of learner (both organization as program) - Provide access to resources
Enable trust	- Knowledge of learner expectations from coach and teaching program - Reason about implications of deviation between learners expectations and teaching program - Adapt teaching program accordingly - Knowledge of learners beliefs - Knowledge of discussion content - Reason about implications of discussion content on learners beliefs: - Intervene accordingly - Create trustful atmosphere -
Connect peers	- Knowledge of learners interest - Knowledge of peer interest - Reason about connection between peer interest - Introduce peers accordingly
Provide Safe Practice Environment	- Knowledge of practice techniques (e.g. role playing. This can be a large number of techniques with specific requirements. For conciseness reasons these will not be discussed here) - Respect privacy
Support motivation to initiate apply and persist TPD (incorporating motivational interviewing)	-

5 Selecting eCoach Functions

Chapter 4 provides a long list of requirements for coaching that will not be implemented in an electronic coach at once. The challenge is to decide what core functions and related requirements can be implemented in an eCoach in an effective way. In other words, the question is which coaching functions we should start to *automate*. In this chapter we describe two principles that can help to make this decision. The first principle is related to task complexity, the second is related to the learning environment.

5.1 Learning environment

Different learning environments offer different benefits and drawbacks. In this paragraph the benefits and drawbacks of a traditional learning environment, an online learning environment and an eCoach (with automated coaching functions) will be compared.

5.1.1 Traditional learning environment with a human coach

What we understand by a traditional learning environment in this context is a classroom environment. This classroom environment is characterized by the fact that the teacher and learners meet at a particular time and place in a room especially designed and furnished to provide an optimal learning environment. The teacher and learners are physically present at all times, which facilitates interpersonal interactions [Małgorzata Rzeźnik, 2005].

Opportunities

The *face-to-face interaction* provides a number of advantages. It's easier to share experiences and go into discussion. Communication is enhanced by the nonverbal dimension and people can pick up each other's moods and emotions (the affective aspects). In general problems are easier identified and different viewpoints can be shared while avoiding misconceptions.

Drawbacks

A drawback of the face-to-face interaction can be that there are limited hours of instruction and the teacher has to divide his attention between the group of participants. Besides that, learners all have to follow the same tempo and course. Individualization is not possible.

5.1.2 Online learning environment (no coach)

In this report we use the term online learning, but many different names are currently used in literature and practice to convey the same meaning, such as e-learning, Internet learning, Web-based learning etc.. A currently used definition to describe online learning (Folinsbee, S., 2008) is "the development of knowledge and skills through the use of information and communication technologies (ICTs) to support interactions for learning—interactions with content, with learning activities and tools, and with other people." We comply with this definition.

Opportunities
A major opportunity the online learning environment offers is access to content anywhere, anytime which allows a-synchronic learning. People can choose their own time and speed, without being dependent of the availability of teachers and progress and interactions are documented by the system. Furthermore, the medium allows *adaptability to the needs of the individual learner* when it comes to content, learning activities and planning. Finally, online learning is accessible for large groups of people and is less expensive.

Drawbacks
A drawback is that, though there is an abundance of information gathering, there is no information on the state of the learner other than his performance.
Competencies teachers have to learn are not standard competencies. The required teaching skills have to be assessed by an experienced coach to give appropriate and tailored directions. Besides that, teachers may have their personal teaching style and preferences. There is not a standard method that should be used by all teachers. This must be assessed by an experience coach as well.
There is a lack of affective adaptation to the learner. Furthermore, current online learning programs can adapt to the performance of the user, but not reason about the performance of the user and thus make more complex inferences on why certain aspects of the material are giving more difficulties then others.
Besides that, bonding and emotional feedback lacks because the absence of direct contact. Judgment of skills and behavior based on visual cues is not possible.
There is not a regular moment in which learners gather at the same location. Therefore, more effort is needed to encourage learners to work together and discuss the learning material.

5.1.3 eCoach

The online learning environment could be enhanced by a virtual coach (i.e., providing additional opportunities and overcoming some drawbacks of online learning environments). An eCoach can offer additional guidance tailored to the individual learner needs and address attitudinal, motivational and emotional factors influencing the learning (affective). The eCoach is characterized by more intelligent functionality like reasoning on basis of a user model that incorporates *more* than performance.

5.2 Task complexity

5.2.1 Generic cognitive coaching tasks

In generic terms, four cognitive tasks can be distinguished for coaching: Awareness, Assessment, Adjustment, leading to Action. This 4A model is presented in Figure 4. The terms are explained below.

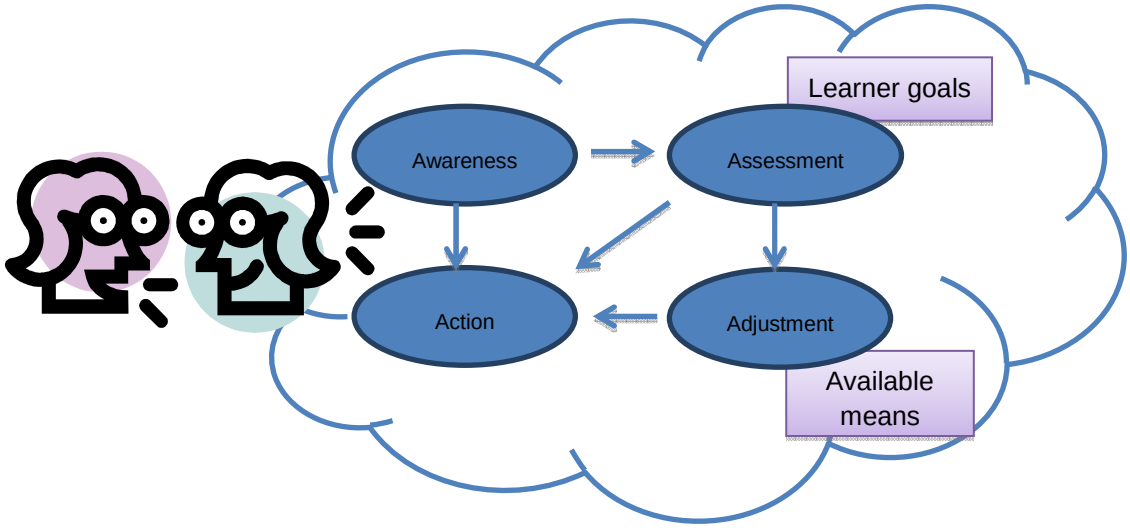

Figure 4 The 4A model for coaching functions.

Awareness
The coach must be aware of the progress the learner is making. How much is the learner participating and practicing, what are the test results, what is the input in group discussions, etc. Progress relates to learning performance indicators, but also to other relevant factors such as motivation, attentiveness, and self-efficacy. \

Assessment
In order to check that the learner is achieving his or her goals, motivated, etc., the coach should make an assessment. For example, user goals are compared with the achievements. The assessment function guards if there are no deviations from the user goals.

As long as there are no deviations, the program can continue as planned. This is illustrated by the arrow from Awareness to Action.

However, when there is a deviation between goals and achievements, interventions must be made. In some cases, these interventions are techniques that are included in the used method. For example, the learner can be motivated to perform exercises, use self-reflection techniques or participate in peer groups. Rules can be applied to decide what interventions to make.

If these interventions do not work, an adjustment in the program might be necessary.

Adjustment
Adjustment takes place when a more fundamental intervention is needed. ‘Rule based’ intervention techniques do not fit anymore and a thorough evaluation is needed. Adjustment of the program requires more specialist knowledge and experience from the coach for making the right decisions. Therefore the coach must have knowledge about available means that can be applied to make an adjustment.

Action
Action refers to the actions that should be taken by the coach. These actions are a result from the output of the other three functions.

5.2.2 *Cognitive complexity*

The complexity of the functions is an important criterion for allocating coaching functions to a human coach or an eCoach (i.e., to automate the coaching).
The more complex the function, the more difficult it will be to develop eCoaches that can perform them. By identifying the complexity of functions it can be decided how they should be allocated.

Based on the model of Rasmussen (1986) we can distinguish three complexity levels.

The first level of complexity is on a 'stimulus response' level. Functions at this level are very easy to perform, almost automatically. Functions at this level can be easily automated and, consequently, easily performed within an online learning environment.

The second level of complexity refers to functions that are 'rule based'. With a certain input rules have to be applied to decide what action has to be performed. Rules are defined like 'If conditions are X, then action is Y'. Automation of functions at this level is more difficult, but if the rules are clearly defined it is possible.

The third level of complexity refers to functions that require expert knowledge. Knowledge from education, experience and knowledge of the world is needed to solve complex problems. Automation of functions at this level is very difficult or impossible. Therefore, the performance of functions at this level always requires a human coach with the right knowledge and experience.

5.2.3 *Complexity and generic coaching functions*

There is a relation between the generic functions and complexity. The relation between assessment and action is typically skill-based. If everything goes as planned, simple preprogrammed actions can be taken to keep on track.
If there are deviations identified during the assessment, interventions have to be made. Often these interventions are obvious, for example, doing extra exercises. Deciding what intervention to take can be decide on a rule basis. 'If performance X is too low, intervention Y has to be made'. Although simple, knowledge about the user goals, user performance and intervention methods are required. Therefore the complexity level is higher. An eCoach can help in assessing the goals and decide on the actions that have to be taken.
Adjustment requires specific expert knowledge and experience and is therefore very complex. Adjustment functions require a human coach.

Function	**Complexity**	**Allocation**
Awareness – Action	Low	Online support
Awareness – Assessment - Action	Medium	eCoach
Awareness – Assessment – Adjustment - Action	High	Human Coach

By analyzing the relation between the requirements and the generic functions, the complexity of the requirements can be rated. On the basis of complexity the requirements can be allocated to an eCoach or a human coach.

5.3 Allocation of functions

Referring to the symbiosis of human and virtual coaching, it can be decided what parts of different functions are best allocated to the online environment, an eCoach and human coach. At the same time it offers a starting point from which the requirements of an eCoach can be defined. Besides that it can be explored what real coach functions might be potentially allocated to the eCoach and what ICT developments are needed to make this possible.

However, a clear description of the subject and context of the learning goals are a prerequisite to perform the allocation in detail. The next step would be to do this in a particular case study.

6 Conclusions and Discussion

eCoaching provides new opportunities to enhance adult learning. There is a rich source of learning theories and methods that are relevant for the development of eCoaches. However, there is no unifying theory and corresponding methodology that can be used to derive a coherent and concise set of eCoach requirements in a direct and unambiguous way. This report presents leading theories and coaching techniques, and a general approach to support adult learning in their professional development. These theories, techniques and approach were used to induce a first set of coaching functions and corresponding requirements. It should be stressed that in a “real” eCoach, some of these functions are automated (distinguishing an eCoach from an online learning program). This report provides the 4A-model to identify or select the functions that can be automated in an eCoach, based on function complexity and characteristics of the learning environment. According to this model, eCoaches can complement online learning programs and human coaches.

In future research, the coaching model and requirements should be applied to a specific professional development case for validation and refinement. Such a study should convey *what* the eCoach should do,
how the eCoach should interact with the learner, and *which* learning outcomes will be realized. In general, such a study provides insight into the specific advantages of the use of eCoaches and how they can be integrated into a development program (i.e., helping the learner to acquire new skills more effectively and efficiently, tailored to learners needs and wishes).

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