

D3.3: Definition of tailored coaching strategies

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Abstract

Coaching strategies are an important element in the Council of Coaches system. In this deliverable, we describe the work performed as part of Task 3.1 and build on the contents of Deliverable 3.1 (*Initial Coaching Strategies and Knowledge Base*). We describe the processes in the designed technical component for the automatic selection of coaching strategies. We also describe how the model of goals and the sets of coaching strategies – which are crucial elements in those processes - could be extended and tailored for the needs for the user. We conclude by discussing the next steps in this iterative development process.

Corrections

v1.0.1 Correctly applied EU logo on header page.

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Symbols, abbreviations and acronyms

CMC	Centre for Monitoring and Coaching
COUCH	Council of Coaches
D	Deliverable
DBT	Danish Board of Technology Foundation
EC	European Commission
ECA	Embodied Conversational Agent
ECC	Embodied Conversational Coach
HBAF	Holistic Behaviour Analysis Framework
ISPRINT	Innovation Sprint
M	Month
MS	Milestone
RRD	Roessingh Research and Development
SU	Sorbonne University
UDun	University of Dundee
UPV	Universitat Politècnica de València
UT	University of Twente
WP	Work Package

Glossary

We provide below a short glossary of terms used throughout this deliverable – and their attributed meaning as used in this document.

Coach – An entity that interacts with a person and in doing so applies coaching strategies. Can be human or software-based.

Embodied Conversational Agent (ECA) – A virtual or robotic human-like character that demonstrates many of the same properties as humans in face-to-face conversation, including the ability to produce and respond to verbal and nonverbal communication.

Embodied Conversational Coach (ECC) – An embodied conversational agent that takes on the role of a coach.

Knowledge Base – A software component that stores facts and rules related to various types of domains including the health domain, user profile and contextual information. Provides easy and open access to other (internal) software components for retrieving and updating information.

1 Introduction

The Council of Coaches application – the development of which is the focus of the Council of Coaches project – contains a council of multiple embodied conversational coaches (ECCs) that coach a user on multiple domains (e.g. physical activity, diet, cognition) simultaneously. The ECCs provide the user with coaching advice based on present knowledge about the topic and the user, and adjust that advice based on new information that is sensed or otherwise conveyed by the user. An important factor in this process are the tailored coaching strategies that the coaches can apply to do so.

In this deliverable, we start by setting out our objectives and defining the main concepts for the coaching process, namely *coaching goal*, *coaching strategy*, *coaching action*, and *dialogue action*. We continue with describing the technical context in which these concepts occur by explaining the processes in a technical component we have designed to realize the automated selection of coaching strategies in the system. Building on the contents of Deliverable 3.1 (*Initial Coaching Strategies and Knowledge Base*) (Beinema, et al., 2018), in Section 5, we describe how the contents and structure for the coaching goals can be defined and we provide an example. We then do the same in Section 6 for the tailored coaching strategies. Finally, we conclude and discuss the next steps in this iterative development process.

2 Objectives

This deliverable provides the definition of a goal model and coaching strategies as part of Task 3.1 and builds on the insights from reviewed literature and technical requirements that were discussed in Deliverable 3.1 (*Initial Coaching Strategies and Knowledge Base*) (Beinema, et al., 2018). The goal model and coaching strategies are used in the processes that will take place in a technical component for automated coaching, for which we also describe the design. The tailoring of the coaching strategies is not solely a process that takes place in this technical component, but that also extends to other components of the overall Council of Coaches system. We illustrate how new goals and strategies can be developed by providing an example for the physical activity domain.

3 Definitions and relations of key concepts

In the following subsections, we will define the concepts of *coaching goal*, *coaching strategy*, *coaching action* and *dialogue action*. While doing so we will illustrate this with a working example in the domain of physical activity.

3.1 Coaching goal

Coaching goals are goals that the coach would like to reach for/with a user. The goals that coaches set form the cornerstone of the coaching strategies. When the ECCs reach all of their goals, the user – for our intents and purposes – no longer needs the Council of Coaches application. A very high level goal for each ECC is always to “keep the user healthy”, but such goals are not actionable in terms of providing coaching actions. Therefore, more specific goals are defined, such as *to inform the user on why they have to take 10.000 steps a day*. Such a goal is more actionable, and the system will be able to generate a coaching strategy that will lead to completion of this goal. Goals can be connected to other goals, either as super-goals or as sub-goals. Each coach in the Council of Coaches system has their own representation of a shared network of goals. We will elaborate more on goals in section 5.

3.2 Coaching strategy

A coaching strategy is a dynamic template for a series of coaching actions. A strategy can be suitable for reaching a certain goal. For example, if we take our example goal of having a user that is informed on why they have to take 10.000 steps a day, then an obvious possible strategy for that goal could be to inform the user about why they should take 10.000 steps a day. Which version of “why” works best for the user is the “dynamic” part of the strategy. For some users, an authoritative strategy (“*Because the World Health Organisation says so!*”) might work, for others a more reasoned approach may be more appropriate (“*Walking improves your physical fitness and thus lowers risk of heart disease.*”). What works best for which user requires knowledge about the user – therefore coaching strategies typically consist of a mixture of “knowledge acquisition” and “information providing” actions.

3.3 Coaching action

A coaching action is a very specific and concrete action that a coach can take in coaching a user. For example, in our example, possible coaching actions to fill in the coaching strategy could be to:

- Explain the user the facts.
- Tell a personalised story.
- Ascertain the user’s knowledge on heart disease.

Such coaching actions are relevant for single-coach scenarios as well as for the multiple coach scenario that is adopted in the Council of Coaches project. In Council of Coaches, specific coaching actions may be directed towards other coaches, if that is determined (or expected) to be a sound strategy, e.g.:

- Explain to another coach, who coincidentally has asked for more explanation, why it is important for the user.

Finally, a coaching action is of itself more than a single “statement” and can consist of multiple dialogue actions.

3.4 Dialogue action

A dialogue action is a statement made by a participant in a conversation. For example, five statements that can be a part of the example coaching actions above are:

- '10.000 steps have been set by the World Health Organization as being the healthy amount of steps.'
- 'I had a grandfather who always sat on the couch and who died of cardiac arrest because of it.'
- 'Well, you see, Ben here has Diabetes and needs to keep a balance between what he eats and how much he moves.'
- 'Do you know the World Health Organization?'
- 'Do you have a family history of heart disease?'

4 Technical context

Before providing further elaboration on the definition of coaching goals and strategies, we will first describe the technical context in which they are used. We will describe the model we have designed to provide the reader with a better understanding of the technical factors that influenced our definitions and designs. We aim to keep this explanation readable and understandable for readers from multiple backgrounds.

In Deliverable 3.1 (*Initial Knowledge Base Design and Coaching Strategies*) (Beinema, et al., 2018), we provided initial designs for the shared knowledge base component of the Council of Coaches system. This Shared Knowledge Base contains knowledge based on the information gathered by the Holistic Behaviour Analysis Framework (for more information on the HBAF see D4.1 (Banos, Konsolakis, Op den Akker, Pelachaud, & Bangalore, 2018)), information from interactions with the user, and information from the connected voice recognition and image recognition platforms. It also contains predefined knowledge. For the purpose of this deliverable we simply distinguish three types of knowledge that is stored (see Figure 1), namely:

- Dynamic knowledge. Knowledge that changes often. E.g., information sensed about the user.
- Semi-static knowledge. Knowledge that might change, but will not change often. E.g. domain knowledge such as 'The World Health Organization advices to take 10.000 steps per day'. This also includes the goal model that all coaches will use a copy of and all strategies that can be used by the coaches if they are defined as part of the strategy set for a coach.
- Static knowledge. Knowledge that is quite factual and common sense. E.g. world knowledge such as 'A week has 7 days'.

The information that is stored in the Shared Knowledge Base is also used by the other components in the Council of Coaches system. For the purpose of this deliverable, we will, from this point on, focus on the generation of the coaching strategies instead of, e.g., the representation of knowledge or the exact technical implementation

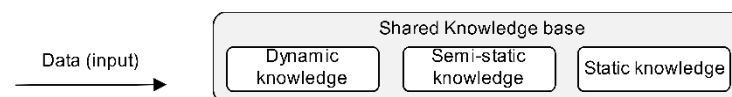


Figure 1: The three different types of stored knowledge.

For each of the coaches in the Council of Coaches system we define a corresponding coach module (see Figure 2). (For those familiar with D5.1, these connect to the dialogue agents in the Dialogue and Argumentation Framework (Snaith & Pease, 2018)).

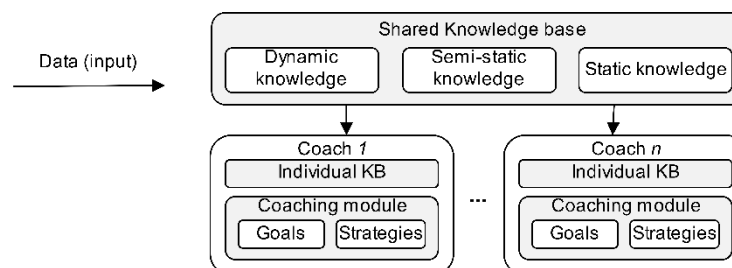


Figure 2: For each of the coaches in the Council of Coaches system there is a corresponding coach module.

A coach module has a representation of goals (see Figure 3), which is an implementation of the goal model that is shared by all coaches. The goals in the representation are connected to each other, that is, if you are in one goal you know which goals are sub-goals of that goal and you can relate goals to each other (see also Section 5).

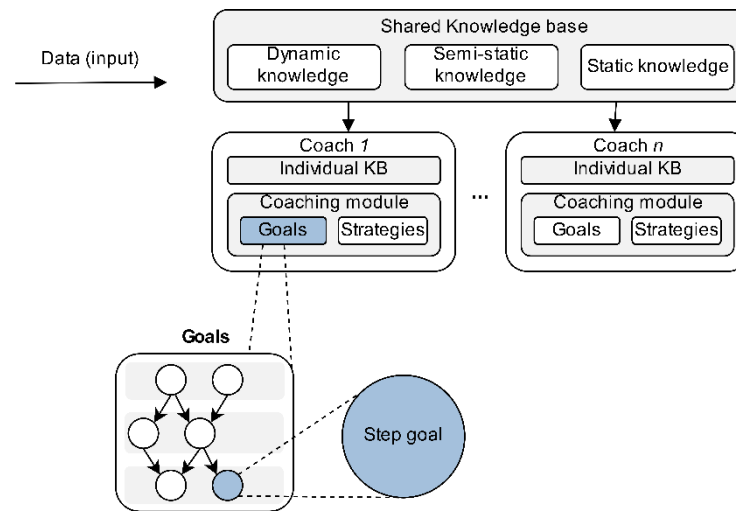


Figure 3: Each coach module has a representation of goals.

A coach module also has a set of possible strategies (see Figure 4), which are the strategies in the set of all available strategies that are relevant for the specific coach (i.e. domain, coaching style, etc.). These strategies can be suitable for reaching a goal, and some can be more suitable for a user than others (depending on the available information about a user).

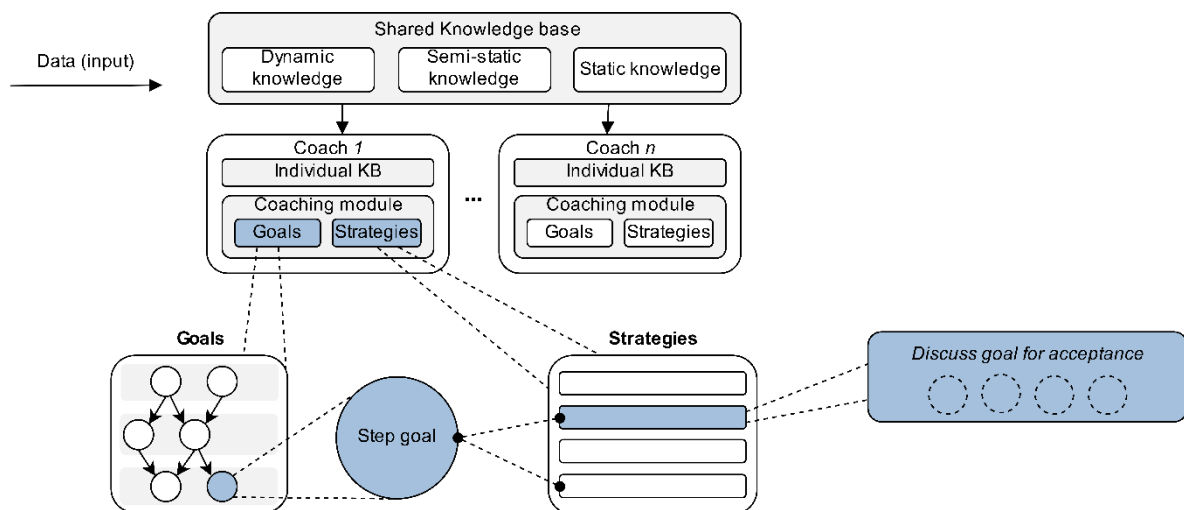


Figure 4: Each coach module also has a set of possible strategies.

We have defined a strategy as a structure that can be seen as a 'template'. This template can be filled in with coaching actions (see Figure 5). This will – after technical processing – result in dialogue actions. This last step will take place in a different component to which the selected strategies are sent.

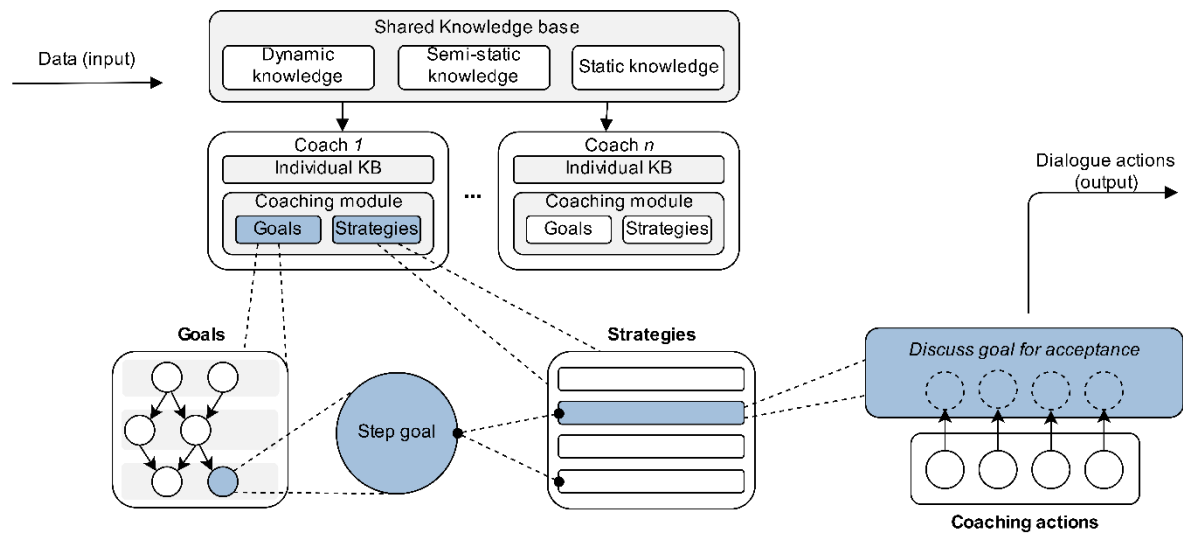


Figure 5: Strategies can be filled in which coaching actions, which results in dialogue actions.

In the next section, we will elaborate on the goal model and the specification of goals.

5 Coaching goals

As defined in Section 3.1, coaching goals are goals that a coach would like to reach for/with a user. From the behaviour change literature research in Deliverable 3.1 (Beinema, et al., 2018), we learned that behaviour change in humans is a process that is dependent on many factors. Users can be in certain stage of a behaviour change process for a specific type of behaviour change (e.g. being more physically active) and in another stage for another behaviour (e.g. following a diet or learning how to deal with stress). There are multiple theories that discuss these stages such as the Rubicon Model of Action Phases (Heckhausen & Gollwitzer, 1987), the Transtheoretical Model of Health Behavior Change (Prochaska & Velicer, 1997), and the Health Action Process Approach (Schwarzer, Lippke, & Luszczynska, 2011). For example, Figure 6 shows the stages as defined by the Transtheoretical Model. These models also describe the mechanisms or processes needed for people to transition from one stage to the next stage, or otherwise transition between stages.

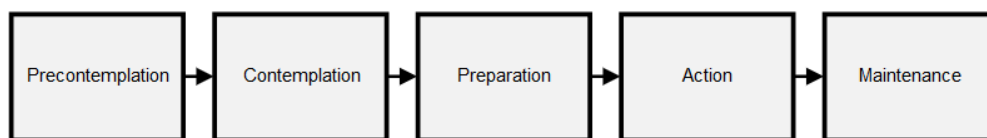


Figure 6: The stages in the Transtheoretical Model of Health Behavior Change.

In order to define coaching strategies that the coaches can deploy to assist the user in reaching their health goals, first, a model of goals is required to define what the coaches should aim to achieve with those strategies. As mentioned, one important aspect is to assist the user in transitioning between stages of change. Other important aspects, that are instrumental in that process, are eliciting motivation and helping the user to build their self-efficacy. This can be done by, for example, applying behaviour change techniques (Michie, et al., 2013) while at the same time keeping the user engaged with and motivated to use the Council of Coaches system.

An important feature of such a model of goals is that the goals that are represented should be concrete, or at the very least should be so at the lowest levels. That is, 'user is healthy' is a great high level goal to strive for, but it is not very practical in the sense that it is not measurable until there is a concrete definition of what it means to be 'healthy'. As illustrated in the previous section, in the designed technical context, goals are represented as a hierarchical network and each coach in the Council of Coaches system will have its own representation of this network for each user. Within a specific coach's representation, goals can be set to be *applicable* for a user or *not applicable* (e.g. step count for a user who cannot walk). Goals can also be set to be completed or not completed. Setting these values for goals is based on the prerequisites that are defined for a goal and that can be met (or not) based on available knowledge.

On the highest level, one of the main goals is the 'user is healthy' goal (another could be 'user is motivated to use the application'). The immediate sub-goals for this goal are related to the domains of expertise of the coaches, that is, e.g. physical activity, diet, social activity, cognition, emotion/mental stability, and target group specific medical aspects (i.e. diabetes type 2, chronic pain, or age related impairments). For a schematic representation of this set of goals, see Figure 7.

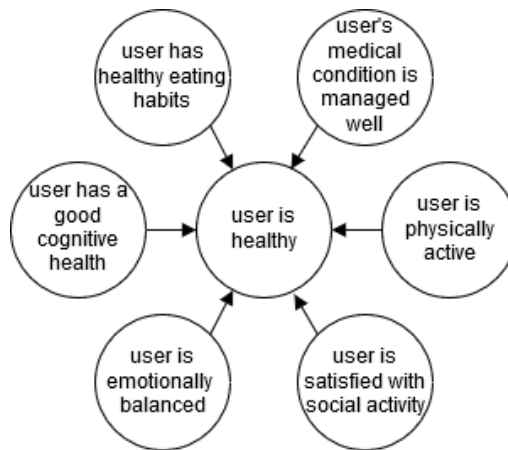


Figure 7: An example of high level coaching goals. The arrows indicate that the connected (sub)goals contribute to achieving a goal.

To inspire the design of the goal structure and to make sure the behaviour change process in users is optimal we have looked at the behaviour change theories discussed in Deliverable 3.1 (Beinema, et al., 2018) and created a diagram containing the factors that are of influence in this process. This diagram can be found in Figure 8. We would like to stress that this diagram is not meant to be a complete and validated model of behaviour change, but that its purpose is to support the creation of our goal structure.

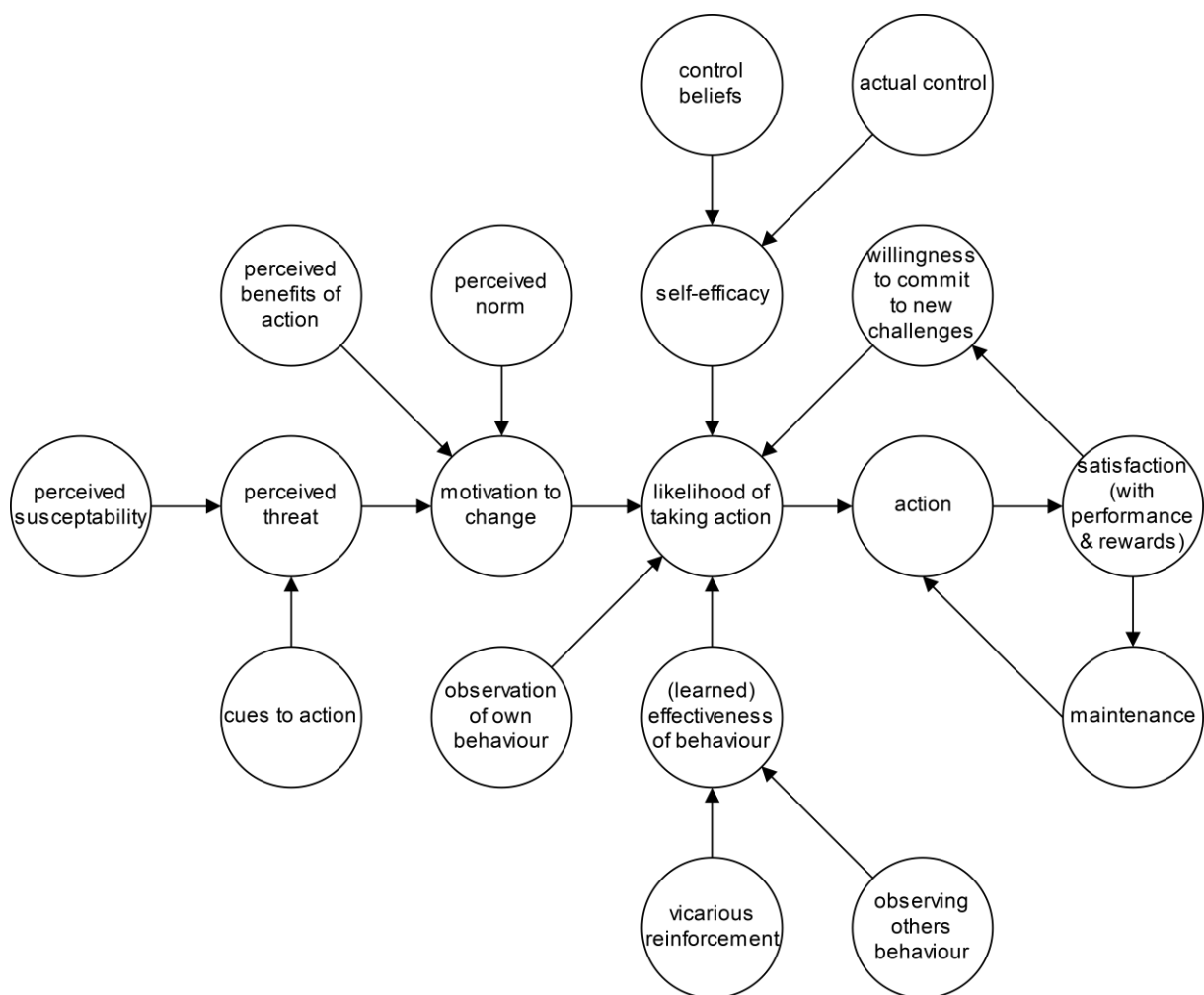


Figure 8: A diagram of influential factors based on the behaviour change theories discussed in D3.1.

We will now zoom in on one of the goals in the previously shown 'user is healthy' structure of high level coaching goals to provide an example of how new parts of a goal structure can be defined. The goal that we will add new sub-goals to in our example is 'user is physically active'. The structure referenced in this example can be found in Figure 9. As mentioned above, the user can be in different stages in the behaviour change process. To help the user transition towards having adopted the new behaviour we have constructed several goals that should contribute to this process.

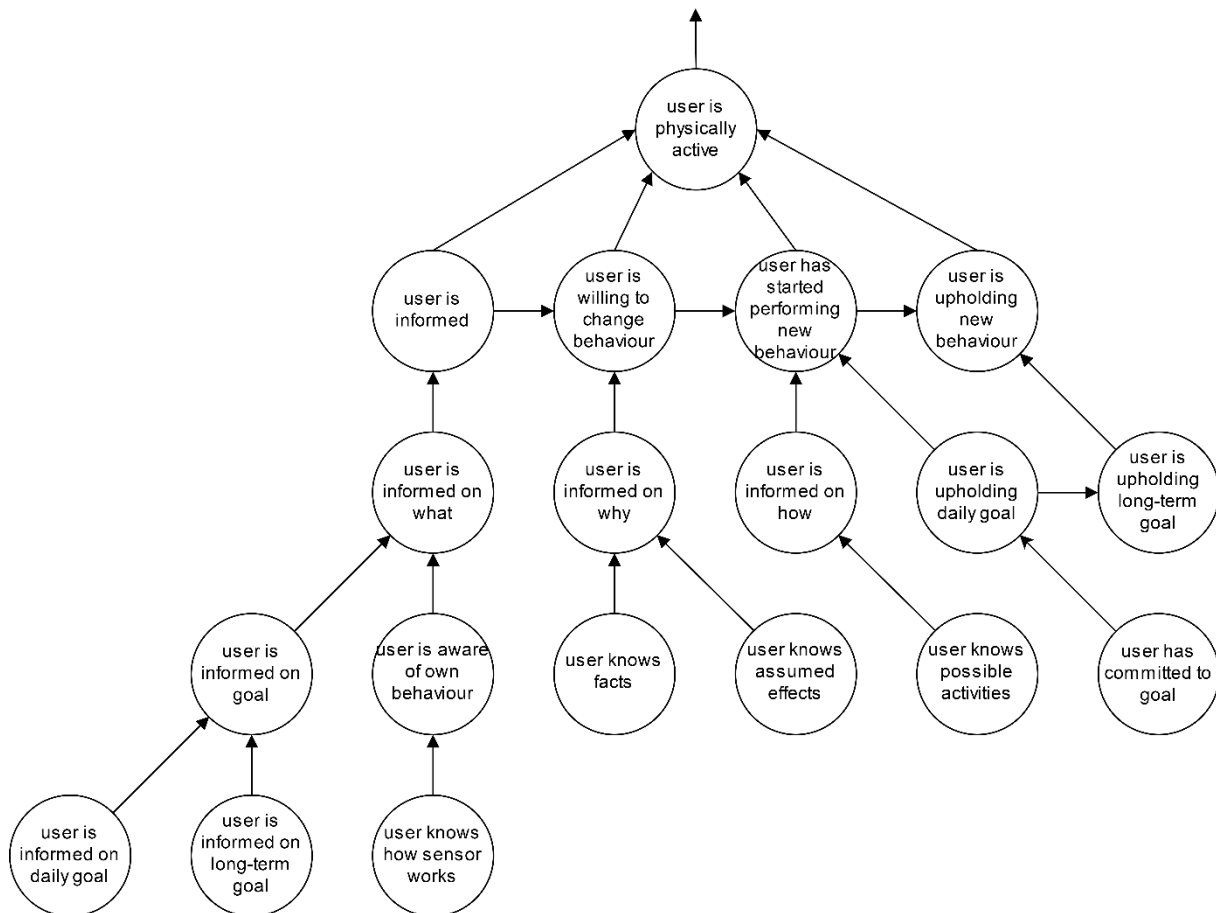


Figure 9: An example extension of the goal structure for the physical activity domain.

First, the user needs to be informed on what behaviour they need to be change and what the goals should be for their specific case. When the 'user is informed' goal is completed, the user knows what healthy physical activity behaviour is and what their current behaviour is. Of course, not all users are the same, and thus the style of informing and whether the user needs to be informed on certain topics are user dependent, as is the computation of the exact goals that are relevant for a user.

Once the user is informed, they need to reach a mind-set in which they are willing to change behaviour. This can be a combined effect of knowing what to do, what the current behaviour is and why changes should be made. Again, not all users are the same, that is, one type of user might respond well to facts, while another responds well to assumed effects (e.g. 'Imagine how nice it would be if you can walk your dog without getting out of breath.' or 'Wouldn't it be nice if you can join the conversations of your colleagues about workouts?').

Once a user is informed and willing to change their behaviour they can begin performing the new behaviour. Essential to this step is that they are informed on possible activities that can contribute to

performing the new behaviour and that they have a daily goal that they are committed to. Finally, the next step is upholding the new behaviour, which is dependent on achieving the long-term goals and upholding the daily routines necessary to keep achieving the goals for the behaviour.

The prerequisites for the goals mentioned above are also important in deciding which goals are most relevant for the selection of coaching strategies. For example, if a user knows that they – as a long-term goal – should increase their amount of walking they cannot be told to ‘take a daily walk in the park’ as a possible activity if they do not live close to a park. If that same user does work near a park, an advice that might be given instead could be to take a walk through the park during their lunch break.

Once the coaching goals for a domain are defined, we can specify strategies that can be tailored to the user and deployed by the coach or coaches to reach those goals.

6 Coaching strategies

Once a coaching goal has been selected, the coaches can deploy coaching strategies that have been deemed suitable for achieving those goals. The coaching strategies that are suitable for a goal are formulated based on insights from the behaviour change theories, coaching literature and behaviour change techniques discussed in Deliverable 3.1 (Beinema, et al., 2018). To provide an example of these coaching strategies, we have defined some example coaching strategies corresponding to the goals that we defined in the previous Section 5. These example strategies are listed in Table 1 below. For each of these example strategies we have listed the corresponding goal, a short description of the strategy, possible prerequisites and some example actions that could be performed as part of the execution of the strategy.

Of course, the power of coaching strategies for behaviour change is in the tailoring process. This tailoring process starts with the selection of the coaches that are suitable for the user. The domains, personalities and appearances for the coaches that result from that selection are an important influence on the engagement of the user. Another influence are the goals that are selected for the user for each coach and the order in which these are addressed through the deployment of strategies. Also, the specific values for the goals that are set is a second aspect of goals that can be tailored per user. Following the selection of goals, the selection of strategies that are suitable to help the user reach that goal provides another tailoring possibility.

Once a strategy has been selected for deployment, the coaching actions that make up the execution of that strategy can be tailored using derived knowledge about the user. For example, actions may differ based on the user's motivation type or context aspects. Specific examples include the involvement of other coaches (A: 'Why not take a walk?' B: 'Ooh, through the park! What a wonderful idea.') or tailoring the conversation surrounding the topic to the user.

Finally, the dialogue actions, that are the result of deploying coaching actions to fill in the strategies, can be tailored to the user, both on a sentence/word level ('walking in the park with their dog' instead of just 'walking') as well as a performance level (tone of voice, facial expressions, etc.). The tailoring on this level is a combination of knowledge about the user and the personality of the coaches that we selected at the start of the process. In every step of the tailoring process, the list of elements that we identified in Deliverable 3.1 from the behaviour change theories can be used as an overview of possible features that differ per user.

Goal	Strategy	Strategy prerequisites	Example action(s)
user is informed on daily goal	Inform user on the daily goals	<ul style="list-style-type: none"> user not informed about daily goals 	Inform user on standards for their age and gender (and if applicable, adjust for disabilities).
user is informed on long-term goal	Inform user on the long-term goals	<ul style="list-style-type: none"> user not informed about long-term goals 	Inform user on long-term goals for their age and gender.
user is aware of own behaviour	Provide user insight into own behaviour	<ul style="list-style-type: none"> user is not aware of own behaviour 	Inform user on current behaviour (e.g. 'You currently take 2000 steps per day on average').

			Inform user on current behaviour in comparison to standard/goal.
user knows how sensor works	Inform user how the sensor works	<ul style="list-style-type: none"> user has sensor user not informed about sensor 	Inform on how the sensor works through conversation.
			Inform on how the sensor works by providing the user with a linked resource. E.g. instruction video.
			Explain to one of the other coaches how the sensor works.
user knows facts	Inform user on facts	<ul style="list-style-type: none"> user not informed about facts 	Frame facts to be learned as a story.
			List facts in a conversation.
			Let the user ask questions about the topic and answer these questions.
			Quiz the user about their current knowledge and correct where necessary.
			Have a conversation about the facts with another coach.
user knows assumed effects	Frame assumed effects in social context	<ul style="list-style-type: none"> user is informed of behaviour that can be changed 	Include assumed effects in a story ('I had a grandfather who started to move more and who had more energy').
			Frame assumed effects in a social context (e.g. 'imagine how nice it will be to be able to play with your grandchildren without getting out of breath').
user knows possible activities	Inform user on possible activities	<ul style="list-style-type: none"> user does not know possible activities 	List possible activities in conversation

			Provide user with link to website with possible activities.
			Suggest user to discuss possible activities with friends.
user has committed to goal	Perform techniques related to Goal Setting Theory (Locke & Latham, 2002) to let user make goal their own.	<ul style="list-style-type: none"> ▪ user has been informed on what the daily goal should be (ideally) ▪ user is informed on long-term goal ▪ user knows their current behaviour ▪ user knows possible activities 	Make the goal achievable and still challenging. E.g., decide on a number of steps per day based on previous steps per day, the final daily goal.
			Adjust the goal slightly based on user input.
			Decide when and how the user will perform activities that help them reach the goal.
			Perform goal setting routine with user while other coach suggests to make the goal more difficult/easy.
user is upholding daily goal	Help user uphold daily goals	<ul style="list-style-type: none"> ▪ user has daily goal ▪ user knows possible activities 	Remind the user to perform possible activities.
			Ask user about problems with upholding daily goals and suggest solutions.
			Suggest user to ask friends or family for social support.
			Provide user with feedback.
user is upholding long-term goal	Help user uphold long-term goals	<ul style="list-style-type: none"> ▪ user has long-term goal 	Remind the user to keep working towards long-term goal.
			Provide user with tips/tricks to make behaviour a habit.

			Provide user with feedback on their performance.
			Provide user with rewards from reward system (e.g. badges).

Table 1: An overview of example coaching strategies that correspond to the goals that were presented in the previous goal example.

7 Conclusion and future work

In this deliverable, we started with providing definitions for the *coaching goal*, *coaching strategy*, *coaching action*, and *dialogue action* concepts. We then described the technical context in which the tailored coaching strategies are used by describing the coaching model that we designed for their selection. As shown in Section 4, an important factor in selecting the correct coaching strategy is that the coaches have a shared model of coaching goals. In Section 5, we have discussed an example of how this model of coaching goals can be extended for the physical activity domain and in Section 6, we have provided insights on the construction of corresponding strategies for the goals added in our example and we have discussed how the process can be tailored for the user.

As previously stated, the design of coaching strategies and their selection process are iterative processes and we will continue to verify and improve our goal models and strategy sets. In order to do so we will apply the following three approaches. First, we will continue to define goals that are relevant for the coaches' domains and for these goals we will write dialogues between the coach(es) and a user in which these goals are discussed and/or strategies are deployed to achieve these goals. By formulating these concrete example dialogues, we apply a practice to technology approach that allows us to critically evaluate our existing models based on new insights.

Second, the work performed by other work packages such as the qualitative and quantitative studies with end-users (older adults, chronic pain, and diabetes type 2 patients) and stakeholders that are described in D2.3 (Broekhuis, et al., 2018) elicit user requirements and give insights in the wishes, needs and expectations they have for the system. These insights can be used for further specification of goals and strategies and defining the correct tailoring aspects of those goals and strategies in the atomisation process. This also holds for insights obtained in the evaluation studies and other studies that take place in various work packages.

Finally, we will discuss the coaches' domains with experts in the field. This will allow us insights in real-world situations that occur for the specific domains, and it will allow us to gain insights in the strategies that these experts deploy in these situations for various types of users and additional goals that are set in practice. As part of our iterative process, these experts will also be asked to take part in future evaluation sessions to verify the advice that the system provides and to advise us on possible extensions.

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