

E-coaching systems

What they are, and what they aren't

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Abstract The ongoing digitalization and automation of coaching practices is rapidly changing the landscape of coaching and (health-related) self-improvement. The introduction of a new class of support technologies—“e-coaching systems”—promises to deliver highly personalized, timely, around-the-clock coaching in a wide variety of domains and to a broad audience. At the same time, the introduction of these systems raises a number of practical and ethical concerns regarding, for example, privacy and personal autonomy, that deserve careful consideration. Unfortunately, constructive conversations about these technologies are hindered by the lack of a precise understanding of what constitutes an e-coaching system and how e-coaching systems differ from other types of behavior change interventions. The broad and inclusive definitions that have been offered in the recent literature facilitate a systematic underestimation of the impact that the introduction of e-coaching systems will have, by allowing discussions to include examples of systems with which people are familiar but which lack the level of sophistication and independence needed for a genuine process of coaching. As a consequence, specific concerns that arise with sophisticated, adaptive systems that form their own perspective on a

user's health and behavior and from that perspective shape persuasive interactions, remain out of focus. This paper aims to remedy this situation by proposing a more narrowly construed definition of e-coaching systems.

Keywords E-coaching systems · Behavior change support · Definition · Policy-making · Ethics

1 Introduction

As is evident from the research presented in this special issue of Personal and Ubiquitous Computing, there is an ongoing movement, both in industry and academia, toward digitalization and automation of coaching practices in a wide variety of domains. These include promoting physical activity [19] and regulating nutritional intake [4], but also domains that are traditionally thought of as clinical domains such as the treatment of depression [32] or insomnia [3].

Broadly speaking, these developments in designing and engineering autonomously operating *e-coaching systems* are aimed at supporting individuals in their self-regulation and goal striving efforts. In the context of health, this aim is often expressed in terms of assisting people with self-care or self-management, with the expectation that such assistance will increase the extent to which people can be self-reliant. This expectation, coupled with the promise that digitalization and automation allow timely, around-the-clock coaching to be made available to a much wider audience than is currently the case with face-to-face coaching, explains for a large part the *prima facie* attractiveness of such technologies.

At the same time, these developments raise a number of concerns, for example about privacy (Who owns and who can access the collected data?), fairness considerations (Who has access to the best e-coaching systems?), and

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personal autonomy (How to deal with an e-coaching system’s potential for being manipulative?).¹ In addition, the introduction of these technologies stands to significantly change people’s relationships with medical professionals and caregivers, for example due to the detailed insights all parties can potentially have into a person’s behaviors and preferences, but also because introducing e-coaching systems means introducing a new source of authority into the dialogue between parties.

Taken together, these considerations elicit a need to critically assess the implications of introducing these types of technologies into our healthcare systems, and into society more generally. This need has been recognized, and in the recent past, several research projects have been instantiated to engage in this assessment. For example, in 2014, the Dutch Rathenau Institute published an advisory report on the current developments concerning e-coaching systems [20], and in 2015, the Tilburg Institute for Law, Technology and Society published a report on the ethical and legal preconditions for e-coaching acceptance [23]. The reports emerging from these assessments are thorough and provide good overviews of the types of considerations that should be taken into account when making policy decisions surrounding e-coaching systems. However, what has remained underexposed thus far is how important it is to have a clear definition of what e-coaching systems are, and what they aren’t.

As of yet, there is little consensus in the literature about what strictly constitutes an e-coaching system and how e-coaching systems differ from other types of behavior change interventions. As I will show in Section 3, the term “e-coaching system” is currently used interchangeably with broad and inclusive terms such as *pedagogical agent* and *behavior change support system*. This usage is problematic because it obscures the level of sophistication and independence that systems need to have in order to engage in a process that can reasonably be considered coaching. In turn, this obscurity about what e-coaching systems are facilitates a systematic underestimation of the impact that the introduction of e-coaching technologies will have, and this has given rise to a number of issues.

First, a broad and inclusive understanding of the concept of e-coaching systems allows discussions about the ethics of e-coaching systems to include examples of systems with which people are familiar, but that do not, in fact, engage in coaching. A commonly heard example in this regard is that e-coaching systems are like advanced reminder systems with behavior-driven and context-driven notifications. However, since familiar reminder systems are

typically not considered to be ethically problematic, having e-coaching systems represented in discussions in this light—i.e. as handy, tool-like systems—obscures concerns having to do with the ways in which sophisticated systems form their own perspective on a user’s health and behavior, may make suggestions for action that the user has not explicitly endorsed, and try to subtly influence people’s behavior and thinking.

A second issue with having an overly broad definition is that it makes it difficult for end users to grasp how they should relate to these systems. As will become evident in Section 4, e-coaching systems develop their own perspective on a user’s health and behavior change trajectory and from that perspective may make suggestions for action that a user has not previously endorsed. As such, it is important for users to be appropriately critical and vigilant with regard to input they receive from these systems, as these users have to assess whether the system’s suggestions are consistent with their own goals and life values. A more narrow definition can help users to better understand both the benefits and the risks involved with e-coaching systems, so that they can strike a balance between trust and vigilance.

A third issue is that an overly inclusive definition leads to unclarity about the minimal technical specifications for designing and building systems that can reasonably be considered to engage in coaching. Having a more narrow definition in place will be beneficial with regard to establishing which features are necessary requirements for such systems, which in turn will provide insight into the technical expertise that designers and engineers will need to have or acquire in order to build systems that meet these requirements. Having the minimal requirements in view is also important for identifying specific technical areas that would profit from further development.

Finally, a fourth issue is that an overly inclusive definition may hinder medical professionals in understanding what they can expect from these technologies with respect to their own practices. As the introduction of e-coaching systems stands to change how different parties interact with one another, it is important that medical professionals grasp how e-coaching systems differ from other types of behavior change interventions, such as keeping a digital food journal or sleep diary that only logs and displays one’s behavior over time. Understanding the level of sophistication and independence that e-coaching systems have is crucial for assessing when it is appropriate to recommend a treatment plan that includes an e-coaching system, and when it is not.

All in all, these issues make clear that there is a need for a more precise definition of e-coaching systems. In this article, I will therefore propose a new definition and relate it to existing concepts from the computer science literature. This endeavor has the dual aim of providing both conceptual

¹See [2] for an overview of different types of concerns that arise with e-coaching technologies.

clarity—which may benefit the fruitfulness of conversations between different stakeholders, as well as the discussions about the (ethical) design of these systems—and to spark critical discussion about the definition.

In relation to first aim, one remark needs to be made regarding the term “e-coaching,” as it is also used to describe the practice of coaching *through* technology [27]. In this very broad sense, this means that if a human coach uses technology as a mode of communication (e.g., to get information about a coachee’s behavior or to give feedback), this is considered e-coaching. Consequently, it could be argued that the communication systems that human coaches and coachees use to communicate in this practice are types of “e-coaching systems”. I want to establish here, at an early stage of the article, that this is not with what this article is concerned. Rather, the term “e-coaching system” should be understood as referring to systems that are not just *facilitating* the coaching, but are actually *doing* the coaching. In other words, the interest is with human-computer interaction, and not with computer-mediated communication. Having this distinction in the background will hopefully help in attaining the conceptual clarity this article aims to provide.

The remainder of this article is structured as follows. First, I will briefly elaborate on what I take coaching to be. Second, I will discuss three initial characterizations of e-coaching systems as found in recent literature. There, I will argue in more depth that these are broad and inclusive characterizations which, by not sufficiently capturing the level of sophistication and independence that is associated with a genuine process of coaching, contribute to the issues described above. Third, I will propose a more narrowly construed definition of e-coaching systems and use that definition, together with existing concepts from the literatures on autonomous agent systems and behavior change support systems, to provide a list of eight features that I believe are necessary for systems to have in order to qualify as e-coaching systems. The paper concludes with an examination of three key implications of the proposed definition.

2 Characterizing coaching

In order to define e-coaching systems in a meaningful way, we first need a rough approximation of what coaching is. Unfortunately, there are many definitions of coaching, with very little consensus about them (see for example [12, 13]). Ives [13] distinguishes no less than nine different approaches, ranging from humanist approaches (where the focus is on personal growth) to behaviorist approaches (where the focus is solely on changing behavior) and from cognitive approaches (where the focus is mainly on developing adaptive thoughts) to goal-oriented approaches [13].

With the latter type of approach, coaching is “essentially about helping individuals regulate and direct their interpersonal and intrapersonal resources to better attain their goals” [10, p. 153].

With e-coaching systems, the goal-oriented approach appears to be the dominant strategy. While designers and developers do take different approaches to offering support—some put more emphasis on changing people’s attitudes while others focus more on the behavioral outcomes—the support they offer is typically in the service of goal striving. Let us therefore examine what a goal-oriented coaching approach consists in. Ives writes:

The primary method is assisting the client to identify and form well crafted goals and develop an effective action plan. The role of the coach is to stimulate ideas and action and to ensure that the goals are consistent with the client’s main life values and interests, rather than working on helping the client to adjust her values [...] [13, p. 102]

In much the same vein, Hayes and Kalmakis [12] paraphrase Stober as stating that “coaching is viewed as a customized, collaborative relationship that elicits the client’s potential for self-awareness, for understanding the meaning of his or her unique situation, for visualizing change, and for making choices and plans to achieve a goal” [12, p. 556].

What both citations highlight is that coaching is an ongoing process between two parties who have a collaborative relationship that focuses on creating opportunities for improving self-understanding, increasing self-monitoring, and supporting people’s plan-making in order to improve goal striving. The challenge then will be to find a set of criteria that a system should meet in order to meaningfully say that the system is engaged in coaching. Before I present my own definition, it will be instructive to look at the current state of the literature on e-coaching systems to see how this relatively new term is currently being used.

3 E-coaching systems in the literature

In November 2014, the Dutch Rathenau Institute published an advisory report on the current developments concerning e-coaching systems [20]. Written for a broad audience, it discusses the trend observed in coaching practices toward the digitalization of both coachees and coaches and gives an assessment of the societal impact that these developments may have. In the report, the notion of “e-coaching system” is understood in a very broad sense so that it covers a wide variety of systems.

The authors characterize e-coaching systems in terms of three processes: collecting data, analyzing data and determining a coaching strategy, and giving persuasive and

motivating feedback [20, p. 16]. While these conditions might seem quite stringent on first glance, they are actually quite lenient. So much so, in fact, that the class of systems these conditions carve out include systems of which it is not clear in what sense they are taking on the role of a coach. To give an illustration, consider the “Mimo Baby Monitor” (<http://mimobaby.com>) that the authors themselves include as an example of an e-coaching system [20, p. 195]. It is true that this baby monitoring system is technologically advanced in comparison to other baby monitors, in that it reports on a variety of measurements such as body position and skin temperature, and that it offers parents the possibility to configure it to send notifications under certain conditions. Surely such a system may be part of a coaching practice (e.g., coaching first-time parents to take proper care of their infant child) but it is far from evident that the system itself is doing any coaching.

In an earlier paper, Warner [33] characterized e-coaching systems as *pedagogical agents* that provide “questions to coachees and responses based on coachees’ entries or selections” [33, p. 24]. The positive of this characterization is that it highlights the dialogical nature of coaching. The downside however is that the characterization seems at once too broad and too narrow. It can be considered too narrow because pedagogical agents are typically defined as having life-like animated interfaces (see for example [11, 21]), whereas with e-coaching, it is perfectly possible to be coached solely by voice, text or through other interfaces (cf. [3]).

At the same time, Warner’s characterization appears to be too broad in that the level of sophistication of the system is specified very minimally in terms of responding appropriately according to input choices made by the user. If this definition is taken at face value, a simple keyword-based algorithm like that used in Weizenbaum’s [34] “Rogerian therapist” ELIZA [34] could plausibly power a pedagogical agent that under Warner’s definition would be considered an e-coaching system. Again, however, it not clear that such a system should qualify, as it is not evident that the system is engaged in a process of coaching.

In Warner’s defense, it can be argued that additional criteria that determine the system’s minimal level of sophistication is packed into the notion of pedagogical agent. For when computer scientists talk of “agent systems”—or simply “agents”—they are, roughly, referring to computerized systems that, at a minimum, are *embedded in an environment* in which they can *sense* and *operate* and to which they are *reactive* [5, 8, 28, 35]. Beyond these core elements, however, there is no consensus about the constitutive criteria for agent systems. Wooldridge and Jennings [35] for example see *autonomy*—in this context understood as operating without constant human guidance—as a constitutive criterion for agent systems [35, p. 2], while other authors understand the autonomy feature as carving out

a particular subclass of agent systems [28]. Likewise, a number of additional criteria have been proposed that may or may not be considered constitutive to agent systems, most notably *social ability* and *proactiveness* [35, p. 2]. The former is the ability to communicate with other agent systems—for example in *ambient environments* [1]—and with human beings through some kind of language. The latter is the idea that “agents do not simply act in response to their environment, [but] are able to exhibit goal-directed behavior by taking the initiative” [35, p. 2]. In addition, it has been suggested that agents, and pedagogical agents specifically, ought to be able to learn in order to be *adaptive* [9]. As all of these features are highly relevant for coaches, it could be argued that, aside the first point about the animated avatars, Warner’s characterization is in fact apt.

However, recall that the concern was that the characterization was overly inclusive, not that it could not be stretched to cover the whole spectrum of e-coaching systems. Though a charitable reading of Warner’s characterization certainly is less inclusive than the one by Kool et al., it remains vague about which of the features just mentioned are strictly required for a system to count as an e-coaching system. Consequently, the door is left open for interpretations in which these features do not play a role.

To be clear, I do not mean to rule out that e-coaching systems can have varying levels of sophistication; in fact, I contend that they can and do. The point is rather that the minimum requirements for classifying as an e-coaching system should be more strict—and, in any case, more explicit—in order to be able to say something meaningful about the entire class of systems.

Finally, Van Wissen [30] has characterized e-coaching systems as *behavior change support systems* (BCSSs) [30, p. 5]. This term was coined by Oinas-Kukkonen in 2010, and defined as an “information system designed to form, alter or reinforce attitudes, behaviors or an act of complying [...]” [25, p. 6]. In this formulation, BCSSs are introduced on a par with *persuasive systems*: “interactive computing systems designed to change people’s attitudes and behaviors” [7, p. 1]. In later work, Oinas-Kukkonen [26] added that a “special characteristic of BCSSs is that they request [...] emphasis on positive user experience and stickiness to motivate users to engage with them regularly over an extended period of time” [26]. This quote highlights that there will be repeated interactions between the user and the BCSS and that the outcome of the interaction—where the outcome will often be the user’s behavior—will play a role in the feedback that the system gives to the user. Still, adding these characteristics does little to narrow down the class of systems that qualify because the technical requirements remain very minimal. In fact, as Oinas-Kukkonen understands the term, it includes both human-computer interaction and computer-mediated

communication [26, p. 1227]. Moreover, on the human-computer interaction side of things, Oinas-Kukkonen himself allows fairly simplistic systems such “an interactive picture frame for adopting better sitting habits while working at the computer [24]” [25, p. 5] to count as a BCSS.

On the face of it, then, it would seem that Van Wissen would allow this same interactive picture frame to qualify as an e-coaching system. However, from her other remarks in [30], it becomes clear that she is solely concerned with human-computer interaction *and* that she presupposes more complexity in BCSSs than is inherent in the definition of those systems. For example, in [18], Van Wissen and her colleagues focus on “accessibility, adaptability, and interactivity” [18, p. 138]. Moreover, they make an explicit distinction between *simple*, *tailored*, and *model-driven* e-coaching systems [18, p. 139]. The first relates to generic interventions, the second to tailored interventions, and the third to systems that rely on theory-driven models of behavior change to determine the root causes of people’s non-compliance. What this highlights is that the authors are distinctly aware of the different levels of sophistication that behavior change support systems can have. The open question that concerns us here, however, is whether all of these systems should classify as e-coaching systems.

Van Wissen seems to suggest that they should. She characterizes e-coaching systems along three axes of a three-dimensional space. The axes are the “complexity of persuasive techniques, the use of artificial intelligence techniques and whether they utilize user models that have a solid theoretical foundation” [30, p. 261]. This idea is very helpful for understanding on a high level the different aspects that are related to e-coaching systems, but Van Wissen fails to be specific about the lower boundaries of the e-coaching system concept. Though she is adamant that researchers should strive for finding “the e-coaching sweet spot”—where the different dimensions are all represented to some sufficient level—she does seem to allow that systems that have few persuasive techniques, little to none artificial intelligence techniques and are not model-driven *can* be called e-coaching systems.

The advantage of casting a wide conceptual net in each of these cases is of course that it allowed the authors to discuss a wide range of technological developments and to discuss various products already on the marketplace.² The downside of such a broad conception, however, as mentioned in the introduction, is that it allows for simple systems with which we are familiarized in the present to shape our thinking about interactions with technologies of the future. This, in turn, may lead to missed opportunities to proactively make

informed policy decisions that take into account the level of sophistication and independence that these systems will have.

4 Defining e-coaching systems

Moving forward, it will be important to establish a definition that is explicit about the level of sophistication that these systems will have, so that it will be clearer what the design specifications should look like, what people’s expectations of these systems may reasonably be, and which types of concerns and considerations these systems evoke. In what follows, I will propose a definition, and subsequently stipulate eight technical features that I believe are necessary for systems to have in order to meet the definition. Finally, I will discuss three key implications of having a more strict definition in place.

As discussed above, if systems are to be engaged in coaching, it is key that they are able to create and maintain customized, collaborative relationships in which coachees are supported in understanding their situation and in making effective plans for changing their behavior or attitudes in accordance to their own view on how to live their lives. With this in mind, I propose the following definition.

E-Coaching System. An e-coaching system is a set of computerized components that constitutes an artificial entity that can observe, reason about, learn from and predict a user’s behaviors, in context and over time, and that engages proactively in an ongoing collaborative conversation with the user in order to aid planning and promote effective goal striving through the use of persuasive techniques.

Explicit in this definition is that e-coaching systems are adaptive over time to a user’s changing preferences and behavioral patterns, that they are in a relevant sense context-aware, that they can predict what a user is about to do, or how the user will respond to a certain interaction, and that they are able to engage in a conversation with the user in which the system can take initiative and co-determine what the conversation is about. These ingredients, I believe, form the basis for systems that can engage with the user in an interactive process that can reasonably be considered goal-oriented coaching in line with the definitions discussed in Section 2.

The following step is to work out a set of features that systems must necessarily have in order to satisfy the definition. Together, such a set of features can provide a starting point for thinking about concrete guidelines and “best practices” for developing systems that can engage in coaching. In turn, such guidelines can help to establish markers of quality that can be used in various decision-making processes by users, medical professionals, ethicists,

²This approach is understandable particularly for Kool et al. [20], considering that their report is specifically concerned with the trend toward autonomous e-coaching systems.

and policymakers. In what follows, I will propose a minimal set of features that I think are strict enough to rule out simple behavior change systems such as the smart baby monitor from being considered an e-coaching system, without being so restrictive that no systems that are currently in development qualify.

1. The system will need to have *social ability* (see again Section 3) in order to engage in an ongoing conversation with the user. This conversation is crucial for establishing and maintaining a collaborative relationship between user and system.
2. As coaching requires repeated interactions between user and system, the system should be designed to be *credible*, i.e., to be perceived as having expertise and being trustworthy (see [6, p. 8]).
3. In order to stimulate ideas and action, and to assess whether a person's goals are consistent with that person's life values, the system will need to be in some relevant sense *context-aware* (for more on the importance of context for e-coaching systems, see [31]).
4. In order to ask questions that are pertinent to a specific situation the user is in or will be in, and to develop and maintain the trust that is needed for a customized, collaborative coaching relationship, the system will need the ability to ask questions, give feedback, and offer advice that is *tailored* [7] to the individual user. For this, the system will need *learning abilities* to build up and maintain a *personalized user model* (cf. [18, 30]).
5. The system will need to have information on which to base its questions and recommendations, which means it will need to be able to *interface* with (different types of) data streams (e.g., direct user input, but potentially also measurements of physical activities, mood self-reports, sleeping patterns, etc.).
6. The system has to be *proactive* [35, p. 2] in order to initiate interactions with the aim of stimulating action or reflection. For example, the system could invite the user to reflect on his or her commitment to a particular goal, or warn the user at suspected moments of weakness. For this type of proactiveness, prediction of user behavior is key.
7. If the system is to be successful in supporting behavior change, not as a mere instrument, but as a coach, it needs to have some notion of what a behavior change trajectory looks like. For this, it needs to operate on some type of *model of behavior change* (cf. the COM-B model [22] and the COMBI model ([17]; see also [15]).
8. In order to support users in setting themselves up for behavior change success, the system needs the ability to guide its user in a process of future-directed intention formation, also known as *planning*.

As mentioned before, this list contains a set of minimal, necessary features for e-coaching systems. In practice, I foresee that a number of these features will be expanded beyond what is minimally necessary. For example, with regard to tailoring, it is plausible that more advanced e-coaching systems will give their tailored feedback and advice in relation to a specific *persuasive profile* [16], where this profile may even be adaptive to changing circumstances. In addition, with regard to social ability, e-coaching systems that are designed to stage context-driven interventions, are likely to be equipped with the ability for two-way communication with other systems in the ambient environment (e.g., home appliances, but also other e-coaching systems). While I do not think that these features are strictly necessary for coaching, others may have opposing opinions. My hope is that this list, like the definition, will spark a critical discussion in the community about what it takes for a system to be doing the coaching, instead of just facilitating it. Before opening the floor to discussion, however, I would like to conclude this article by discussing three key implications that follow from having this new, more narrow definition in place.

5 Implications

From the proposed definition, it will be clear that e-coaching systems go beyond the mere persuasive presentation of collected data. The first key implication therefore is that the proposed characterization rules out a range of self-regulation support structures as being, in and of themselves, e-coaching systems. For example, it will be evident that persuasive photo frames and smart baby monitoring systems do not qualify as e-coaching systems. That is not to say that such systems—I propose to classify them as “self-regulation facilitators”—cannot play a supporting role in changing people's behaviors or attitudes, or that they cannot be included in a coaching practice. However, it does mean that such systems should be excluded from discussions that are strictly about policies concerned with, and the ethics of computerized e-coaches.

The second key implication is an answer to a question that comes up often in relation to e-coaching systems in contexts concerned with *nudging* [29], namely whether systems that bypass people's rational capacities altogether can qualify as e-coaching systems. The answer to this question, I believe, has to be negative. Of course, the user need not be aware of all persuasive techniques being used by a system, but at a minimum, to qualify as coaching, the user needs to be aware that he or she is being coached.

Finally, the definition makes clear that e-coaching systems are more than just passive, reactive decision aids, as they take an active interest in shaping one's life in accordance

with one's goals. In doing so, they form their own independent perspective on the user and the user's behavior change trajectory. Importantly, this perspective may well differ from how the user sees him or herself. This, in turn, has important normative implications for how people ought to relate to these systems. For example, as alluded to in the introduction, one normative implication is that users should not blindly and automatically endorse the suggestions made by an e-coaching system, however tempting this might be. Instead, users should find a balance between trust and vigilance with regard to the e-coaching system's suggestions, and strive to not become complacent in one's reasoning and actions. Clearly, there is much more to be said about this subject, but here is not the place (but see [14]). The purpose of this example was to bring home the point that a clear definition brings into focus important issues and concerns that would otherwise have been obscured from view.

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References

- Aarts E, De Ruyter B (2009) New research perspectives on ambient intelligence. *J Ambient Intell Smart Environ* 1(1):5–14
- Anderson JH, Kamphorst BA (2014) Ethics of e-coaching: Implications of employing pervasive computing to promote healthy and sustainable lifestyles. In: Proceedings of the third IEEE International Workshop on the Social Implications of Pervasive Computing for Sustainable Living (SIPC 2014), in conjunction with the Twelfth IEEE International Conference on Pervasive Computing and Communications (PerCom 2014), IEEE Computer Society Press
- Beun RJ, Brinkman WP, Fitrianie S, Griffioen-Both F, Horsch C, Lancee J, Spruit AGL (2016) Adherence in automated e-coaching: a case from insomnia therapy. In: Persuasive Technology. Proceedings of the 11th Int. Conf. PERSUASIVE 2016, Salzburg, Austria, LNCS, vol 9638
- Boh B, Lemmens LHJM, Jansen A, Nederkoorn C, Kerkhofs V, Spanakis G, Weiss G, Roefs A (2016) An ecological momentary intervention for weight loss and healthy eating via smartphone and internet: study protocol for a randomised controlled trial. *Trials* 17
- Brustoloni JC (1991) Autonomous agents: Characterization and requirements. Carnegie Mellon Technical Report CMU-CS-91-204, Carnegie Mellon University
- Flanagin AJ, Metzger MJ (2008) Digital media and youth: Unparalleled opportunity and unprecedented responsibility. In: Metzger MJ, Flanagin AJ (eds) *Digital Media, Youth, and Credibility*, Series on Digital Media and Learning. The MIT Press, Cambridge, pp 5–28
- Fogg B (2003) *Persuasive Technology: Using computers to change what we think and do*. Morgan Kaufmann Publishers, San Francisco
- Franklin S, Graesser A (1997) Is it an agent, or just a program?: A taxonomy for autonomous agents. In: Müller JP, Wooldridge MJ, Jennings NR (eds) *Intelligent Agents III Agent Theories, Architectures, and Languages*, Lecture Notes in Computer Science, vol 1193
- Giraffa LMM, Viccari RM (1998) The use of agents techniques on intelligent tutoring systems. In: *Computer Science, 1998. SCCC'98. XVIII International Conference of the Chilean Society of, IEEE*, pp 76–83
- Grant AM, Stober DR (2006) Introduction. In: Stober DR, Grant AM (eds) *Evidence Based Coaching Handbook: Putting Best Practices to Work for Your Clients*. Wiley, New York
- Gulz A (2004) Benefits of Virtual Characters in Computer Based Learning Environments: Claims and Evidence. *Int J Artif Intell Educ (IJAIED)* 14:313–334
- Hayes E, Kalmakis KA (2007) From the sidelines: Coaching as a nurse practitioner strategy for improving health outcomes. *J Am Acad Nurse Pract* 19(11):555–562
- Ives Y (2008) What is 'coaching'? an exploration of conflicting paradigms. *International Journal of Evidence Based Coaching and Mentoring* 6
- Kamphorst BA (in prep.) *Autonomy-respectful e-coaching systems: Fending off complacency*. PhD thesis, Utrecht University
- Kamphorst BA, Klein MCA, Van Wissen A (2014) Autonomous e-coaching in the wild: Empirical validation of a model-based reasoning system. In: Proceedings of the 2014 International Conference on Autonomous Agents and Multi-agent Systems, International Foundation for Autonomous Agents and Multiagent Systems, Richland, SC, AAMAS '14, pp 725–732
- Kaptein M, De Ruyter B, Markopoulos P, Aarts E (2012) Adaptive persuasive systems: A study of tailored persuasive text messages to reduce snacking. *ACM Trans Interactive Intell Syst* 2(2):10:1–10:25
- Klein M, Mogles N, Van Wissen A (2013) An intelligent coaching system for therapy adherence. *IEEE Pervasive Comput* 12(3):22–30
- Klein MCA, Mogles NM, Van Wissen A (2014) Intelligent mobile support for therapy adherence and behavior change. *J Biomed Inform* 51:137–151
- Klein MCA, Manzoor A, Middelweerd A, Mollee JS, Te Velde SJ (2015) Encouraging physical activity via a personalized mobile system. *IEEE Internet Comput* 19:20–27
- Kool L, Timmer J, Van Est R (eds) (2014) *Eerlijk advies: De opkomst van de e-coach*. Rathenau Instituut, Den Haag, Netherlands
- Mayer RE, DaPra CS (2012) An embodiment effect in computer-based learning with animated pedagogical agents. *J Exp Psychol Appl* 18:239–252
- Michie S, Van Stralen MM, West R (2011) The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science* 6
- Niezen M, Adams S, Purtova N, Vedder A (2015) Socially robust ecoaching: Dealing with the ethical and legal preconditions for ecoaching acceptance
- Obermair C, Reitberger W, Meschtscherjakov A, Lankes M, Tscheligi M (2008) perframes: Persuasive picture frames for proper posture. In: Oinas-Kukkonen H, Hasle P, Harjumaa M, Segerstahl K, Øhrstrøm P (eds) *Persuasive Technology*, Lecture Notes in Computer Science, vol 5033. Springer, Berlin, pp 128–139

25. Oinas-Kukkonen H (2010) Behavior change support systems: A research model and agenda. In: Ploug T, Hasle P, Oinas-Kukkonen H (eds) *Persuasive Technology*, Lecture Notes in Computer Science, vol 6137. Springer, Berlin, pp 4–14
26. Oinas-Kukkonen H (2013) A foundation for the study of behavior change support systems. *Pers Ubiquit Comput* 17(6):1223–1235
27. Ribbers A, Waringa A (2015) *E-Coaching: Theory and practice for a new online approach to coaching*. Routledge, New York
28. Russell SJ, Norvig P (2003) *Artificial intelligence: A modern approach*, second. Prentice Hall, New Jersey
29. Thaler RH, Sunstein CR (2008) *Nudge: Improving decisions about health, wealth, and happiness*. Penguin Books, London
30. Van Wissen A (2014) *Agent-based support for behavior change: Models and applications in health and safety domains*. PhD thesis, VU University Amsterdam
31. Van Wissen A, Kamphorst BA, Van Eijk R (2013) A constraint-based approach to context. In: Brézillon P, Blackburn P, Dapoigny R (eds) *Proceedings of the Eighth International and Interdisciplinary Conference on Modeling and Using Context (CONTEXT'13)*, Springer, pp 171–184
32. Van de Ven P, Henriques MR, Hoogendoorn M, McGovern KleinEM, Nelson J, Silva H, Tousset E (2012) A mobile system for treatment of depression. In: Cipresso P, Hoogendoorn M, Klein M, Matic A (eds) *Computing Paradigms for Mental Health. Proceedings of MindCare 2012, in conjunction with BIOSTEC 2012*, pp 47–58
33. Warner T (2012) E-coaching systems: Convenient, anytime, anywhere, and nonhuman. *Perform Improv* 51(9):22–28
34. Weizenbaum J (1966) Eliza—a computer program for the study of natural language communication between man and machine. *Commun ACM* 9(1):36–45
35. Wooldridge M, Jennings NR (1995) Agent theories, architectures, and languages: A survey. In: Wooldridge MJ, Jennings NR (eds) *Intelligent Agents*, Lecture Notes in Computer Science, vol 890. Springer, Berlin, pp 1–39