

Advancing Virtual Coaching in Healthcare: Towards A Unified Terminology and Reference Model

Carola Gißke,¹ Thure Georg Weimann, Hannes Schlieter

Abstract: Virtual coaching applications, designed to facilitate behavior change through adaptive coaching activities, hold promise for personalized interventions, particularly in healthcare. While existing literature explores various aspects of virtual coaches (VCs), there is a lack of comprehensive conceptual analysis, and inconsistent terminology further complicates their understanding. The present paper aims to demonstrate the ongoing work on systematically categorizing and describing the components of VCs and, thereby, creating a reference model reusable for different contexts. Based on a systematic literature review, concepts related to VC interventions will be derived, categorized, and linked to each other, forming a unified framework that could simplify the process of designing VCs and provide the foundation for dedicated building tools in terms of low/no-code platforms. Moreover, the work contributes with a consolidated terminology, and the proposed model may also be used to identify underexplored research areas, enhancing research opportunities in the field.

Keywords: Virtual coaches; Health behavior change; Reference model; Reusability

1 Introduction

Virtual coaching applications, in the sense of autonomous systems aiming to change a user's behavior [WSB22], possess the capability to offer personalized interventions to support individuals in their daily lives. Particularly in the field of healthcare, these applications have great potential to help individuals dealing with chronic illnesses (e.g., diabetes, obesity) by promoting therapy adherence, such as following a healthy diet or increasing physical activity. Existing literature examined various aspects of virtual coaches (VCs) with regard to design principles, objectives, and effectiveness assessments. However, these explorations exhibit diverse focuses and approaches. Notably absent is a comprehensive examination of VCs encompassing their constituent concepts and functionalities. Identifying and abstracting the ingredients of VCs in healthcare could accelerate their development by providing dedicated building tools, facilitating their adaptation to other care scenarios, and promoting interdisciplinary collaboration based on a joint understanding. In particular, generic application building tools recently gained interest in research and practice under the umbrella of "low-code/no-code platforms" (LNCDPs) [BF21]. These platforms aim to enable domain experts (e.g., physicians) to build applications mainly by themselves using highly abstracted mechanisms such as visual modeling languages. Nonetheless, LNCDPs are still subject to the "power/generalality" trade-off, underscoring the need for domain-specific reference models as part of corresponding platforms to enhance development

¹ TU Dresden, FG Digital Health, Helmholtzstr. 10, 01069 Dresden, Deutschland, carola.gisske@tu-dresden.de

productivity (power) [BF21, Bo18]. However, with regard to VCs in healthcare, LNCDPs are in their early stage [Li22] and there is no consistent terminology in the literature for the conceptual description of the VCs components. Some studies examined the challenges of developing digital interventions for behavior change and provide general insights into successful implementation [Lo21][Mi17]. Often, the focus is on the application of behavior change strategies by introducing methods and frameworks meant to support the design process [KYS22][Fo22]. However, these are only general guidelines that do not offer specific descriptions of application components. Some works specifically examined partial aspects of a coaching application, such as behavioral design components as determinants for adherence [Yo20], components of trigger elements for interventions and implications for tailoring them [MB17], or the development of tailored coaching messages [Ak15].

Therefore, the aim of our study is to systematically comprehend and unify the concepts that constitute a VC. By achieving this, the intention is to establish a foundation for enhancing the re-usability of these concepts in the development of new coaching interventions in various health contexts. To address this objective, the following research question was established: *How can we conceptually describe VCs in healthcare with a unified terminology and reference model?*

2 Methodological approach

A systematic literature review was conducted using the PubMed database to derive concepts related to virtual coaching applications. A specific search strategy was developed to account for the diverse terminologies in the field, focusing on medical context, technical implementation, and elements of personalization, context awareness, and adaptability. The search was restricted to titles and abstracts of English and German publications from the last decade, yielding 4578 initial hits, which were then refined to 511 based on reputable journals in Medical Informatics/Digital Health as listed by the Association for Information Systems and Google Scholar (top publications). A significant amount of the literature found deals with coaching or behavior change applications with a human coach as a feedback component, or the feedback provided was based solely on monitoring results and was not adaptive or personalized, which contradicts the definition of a VC presented at the beginning of the paper. Furthermore, the description of the applications with their components was often very rough or was not described, which could be due to the medical context of the studies, but makes the evaluation for the purpose of categorizing components more difficult. Therefore, the papers underwent a thorough relevance assessment by applying several exclusion criteria to ensure the selection of highly relevant research papers involving three authors. These criteria included **E0**, which excluded studies lacking digital software applications, and **E1**, which filtered out coaches not serving health improvement purposes. **E2** ensured that works without at least partial autonomy were excluded, while **E3** focused on eliminating studies lacking context-based adaptation in system output. **E4** ruled out non-patient-facing systems, such as those designed for healthcare professional training, and **E5** targeted papers with insufficiently described system designs with regard to our research goal. Ultimately,

40 papers were included. A non-systematic Google Scholar search was also conducted to identify additional relevant literature. An inductive approach, according to [Ma00], was used to conceptualize the literature and derive the concepts underlying VC interventions. The interventions described in the identified studies were examined and systematically categorized based on their functionalities and components. From these elements, distinct classes were formed, leading to the extraction and derivation of key concepts.

3 Preliminary results and further research

The identified key concepts could be grouped into top-level guiding components, which are interacting and closely coupled. This helps identify guiding design principles and basic components constituting VC interventions. The design components are each associated with defining concepts, which can be configured with a multitude of sub-components. For the component „parameter adaptation“, an exemplary illustration is given of the characteristics that are identified with this concept within the literature. Figure 1 demonstrates the identified design concepts and their relations on an aggregated level.

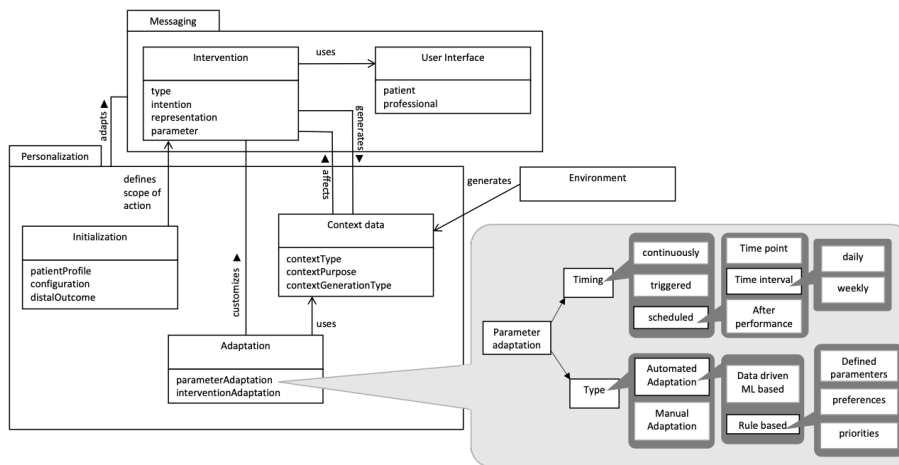


Fig. 1: UML class diagram of identified VC concepts and their associated components with an exemplary detailing of the component „parameter adaptation“

Throughout the course of further work, a comprehensive representation of potential manifestations for all components is intended. Through the detailed elaboration of the underlying principles and their configuration, constitutive design principles can be identified, which lead to a design theory and thus form the basis for the derivation of a reference model. Furthermore, by detailing the model, topic areas in the literature can be identified that have not yet been investigated and thus, provide further research incentives.

Bibliography

- [Ak15] Akker, H. op den; Cabrita, M.; Akker, R. op den; Jones, V.M.; Hermens, H.J.: Tailored motivational message generation: A model and practical framework for real-time physical activity coaching. *Journal of Biomedical Informatics*, 55:104–115, 2015.
- [BF21] Bock, Alexander C; Frank, Ulrich: Low-code platform. *Business & Information Systems Engineering*, 63:733–740, 2021.
- [Bo18] Bock, Alexander C: The power/generalizability trade-off in decision and problem modeling: Theoretical background and multi-level modeling as a resolution. In: *Enterprise, Business-Process and Information Systems Modeling: 19th International Conference, BPMDS 2018, 23rd International Conference, EMMSAD 2018, Held at CAiSE 2018, Tallinn, Estonia, June 11-12, 2018, Proceedings 19*. Springer, pp. 213–228, 2018.
- [Fo22] Ford, K.L.; West, A.B.; Bucher, A.; Osborn, C.Y.: Personalized Digital Health Communications to Increase COVID-19 Vaccination in Underserved Populations: A Double Diamond Approach to Behavioral Design. *Frontiers in Digital Health*, 4, 2022.
- [KYS22] Kaveladze, B.T.; Young, S.D.; Schueller, S.M.: Antifragile Behavior Change Through Digital Health Behavior Change Interventions. *JMIR Form Res.*, 6(6):e32571, 2022.
- [Li22] Liu, Sam; La, Henry; Willms, Amanda; Rhodes, Ryan E: A “No-Code” app design platform for mobile health research: Development and usability study. *JMIR Formative Research*, 6(8):e38737, 2022.
- [Lo21] Lord, S.E.; Campbell, A.N.C.; Brunette, M.F.; Cubillos, L.; Bartels, S.M.; Torrey, W.C.; Olson, A.L.; Chapman, S.H.; Batsis, J.A.; Polsky, D.; Nunes, E.V.; Seavey, K.M.; Marsch, L.A.: Workshop on Implementation Science and Digital Therapeutics for Behavioral Health. *JMIR Ment Health.*, 8(1):e17662, 2021.
- [Ma00] Mayring, Philipp: Qualitative Content Analysis. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 1(2), Jun. 2000.
- [MB17] Muench, F.; Baumel, A.: More Than a Text Message: Dismantling Digital Triggers to Curate Behavior Change in Patient-Centered Health Interventions. *J Med Internet Res.*, 19(5):e147, 2017.
- [Mi17] Michie, S.; Yardley, L.; West, R.; Patrick, K.; Greaves, F.: Developing and Evaluating Digital Interventions to Promote Behavior Change in Health and Health Care: Recommendations Resulting From an International Workshop. *J Med Internet Res.*, 19(6):e232, 2017.
- [WSB22] Weimann, T.G.; Schlieter, H.; Brendel, A.B.: Virtual Coaches - Background, Theories and Future Research Directions. *Bus Inf Syst Eng*, 64(4):515–528, 2022.
- [Yo20] Young, S.D.: The Adaptive Behavioral Components (ABC) Model for Planning Longitudinal Behavioral Technology-Based Health Interventions: A Theoretical Framework. *J Med Internet Res.*, 22(6):e15563, 2020.