JYU DISSERTATIONS 591

Eeva Kettunen

Can my Personal Trainer Be Digital?

Experiences of Digital Coaching Supporting Physical Activity and Exercise

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF INFORMATION TECHNOLOGY

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ABSTRACT

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Due to the decreasing levels of physical activity across different populations, it is important to explore ways to support people in increasing their physical activity. Information systems (IS) have been involved in physical activity in various ways, including through sport and wellness technology. Even though the use of such technology has been proven to be somewhat effective, there is still a need to develop solutions that are more personalised and motivational and provide instructive assistance. Digital coaching is a relatively new concept that brings these elements into sport and wellness technology to make it more engaging and motivational. Digital coaches not only provide feedback but also offer continuously updated advice and suggestions without requiring any human interaction. Due to the novelty of digital coaching solutions, there is a lack of research related to sport and wellness technology digital coaching, and particularly its motivational influence. This thesis focuses on investigating from both a psychological and a practical point of view how digital coaching in this way can support different types of users in terms of physical activity. It includes three intervention studies that use both quantitative and qualitative research methods. The findings of this thesis show how digital coaching can influence a user's exercise self-efficacy and exercise motivation. The results also identify people's experiences of using digital coaching and how they think it should be developed further to provide better support. The findings highlight the potential digital coaching possesses for increasing self-efficacy and motivation towards exercising, such as through increased awareness towards one's own physical activity and bringing variation and support to exercising. However, functionality and usability related problems together with lack of personalisation can decrease the positive motivational influence of the digital coach. The findings aim to provide different stakeholders, including developers, marketers, users and healthcare professionals, insight into the usage and motivational influence of digital coaching.

Keywords: digital coaching, sport technology, wellness technology, physical activity, motivation, self-efficacy, self-determination theory

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Kettunen, Eeva
Voiko henkilökohtainen valmentajani olla digitaalinen? Kokemuksia fyysistä aktiivisuutta ja liikuntaa tukevasta digitaalisesta valmennuksesta
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Ihmisten fyysisen aktiivisuuden ja liikunnan määrä on vähenemässä ja siksi on tärkeää löytää tapoja, joilla tukea erilaisia ihmisryhmiä fyysisesti aktiivisempaan elämään. Informaatioteknologiaa on hyödynnetty liikunnan tukena esimerkiksi liikuntateknologian kautta. Vaikka liikuntateknologian käyttö on osoittautunut hyödylliseksi, on kuitenkin tarve kehittää liikuntateknologisia laitteita ja sovelluksia personoidumpaan, motivoivampaan ja ohjeellisempaan suuntaan. Digitaalinen valmennus on uudehko konsepti, joka tuo liikuntateknologiaan näitä elementtejä lisäten samalla käyttäjän mielenkiintoa ja motivaatiota. Digitaalinen valmentaja ei pelkästään anna palautetta vaan myös ajantasaista ohjeistusta ja ehdotuksia liikuntaan liittyen. Liikuntateknologisesta digitaalisesta valmennuksesta tai sen vaikutuksesta liikuntamotivaatioon ei toistaiseksi ole paljoa tutkimustietoa. Tämä tutkielma tarkastelee sitä, miten digitaalinen valmennus pystyy tukemaan erilaisia käyttäjiä liikunnan parissa liikuntapsykologisesta ja käytännöllisestä näkökulmasta. Tämä tutkielma sisältää kolme interventiotutkimusta, joissa on käytetty sekä määrällistä että laadullista tutkimusmenetelmää. Tämän tutkielman tulokset osoittavat miten digitaalinen valmentaja voi vaikuttaa käyttäjiensä liikuntamotivaatioon sekä liikunnalliseen minäpystyvyyteen. Tulokset myös kuvaavat sitä, miten ihmiset kokevat digitaalisen valmennuksen käytön ja miten heidän mielestään digitaalista valmennusta voisi tulevaisuudessa kehittää entistä toimivammaksi. Tulokset osoittavat digitaalisen valmennuksen potentiaalin liikunnallisen minäpystyvyyden ja motivaation kasvattamisessa, jotka se mahdollistaa esimerkiksi lisäämällä tietoisuutta omasta fyysisestä aktiivisuudesta sekä tuomalla liikuntaan tukea ja vaihtelua. Toimivuuteen ja käytettävyyteen liittyvät ongelmat samoin kuin riittävän personoinnin puuttuminen voivat kuitenkin haitata digitaalisen valmentajan käytön positiivista vaikutusta. Tulokset tarjoavat myös eri käytännön toimijoille, kuten liikuntateknologian kehittäjille, markkinoijille, käyttäjille sekä liikunnan ammattilaisille johtopäätöksiä ja suosituksia liittyen digitaalisen valmennuksen kehittämiseen ja sen hyödyntämiseen liikuntaa edistäviin tarkoituksiin.

Avainsanat: digitaalinen valmennus, liikuntateknologia, hyvinvointiteknologia. fyysinen aktiivisuus, motivaatio, minäpystyvyys, itseohjautuvuusteoria

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This journey started by accident six years ago when I was recruited in a physical activity related research project to the Faculty of Information Technology due to my background in sport and exercise psychology. Even though working in information systems scared me, I took the challenge, and I am very happy I did. I have never been, nor still am, a wizard when it comes to using or understanding technology. I had also never considered myself a researcher and the thought of starting a PhD seemed a bit strange in the beginning. Regardless, here we are. My journey has been full of new experiences, and I have learned a lot. These past years have taught me that everything is possible with the right attitude and that I should always stay open minded to new opportunities.

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During these past six years I have had a chance to get to know and work with amazing people. A special thank you is in order to Markus Makkonen for

During these past six years I have had a chance to get to know and work with amazing people. A special thank you is in order to Markus Makkonen for being a co-writer in many of my papers and for the patience needed for trying to teach me the basics of quantitative methods. Thank you Panu Moilanen and Hanna Vehmas for believing in me and helping me to get hired for the Biogame project where this all started. During my PhD journey I have had the pleasure to have many research related conversations with numerous academic people, especially from our faculty. These conversations have taught me a lot about how to be a researcher. However, I am even more grateful for conversations related to life in general and the fun experiences I have shared with all of you in and outside work. There are just too many of you for me to name here. Thank you all for making me feel at home in our faculty.

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Jyväskylä 30.11.2022
Eeva Kettunen

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II Kettunen, E., Critchley, W., & Kari, T. (2019). Can Digital Coaching Boost Your Performance? : A Qualitative Study among Physically Active People. In Proceedings of the 52nd Hawaii International Conference on System Sciences (HICSS 2019) (pp. 1331-1340). University of Hawai'i at Manoa. Proceedings of the Annual Hawaii International Conference on System Sciences. https://doi.org/10.24251/hicss.2019.163

III Kettunen, E., Kari, T., Makkonen, M., Critchley, W., & Sell, A. (2019). Digital Coaching among University Students with Low Levels of Physical Activity : A Quantitative Intervention Study on Exercise Self-efficacy. In A. Pucihar, M. Kljajic Borstnar, R. Bons, J. Seitz, H. Cripps, & D. Vidmar (Eds.), 32nd Bled eConference : Humanizing Technology for a Sustainable Society (pp. 861-880). University of Maribor. https://doi.org/10.18690/978-961-286-280-0.45

IV Kettunen, E. (2021). Using Digital Coaching to Promote Physical Activity to University Students with Low Levels of Physical Activity : A Qualitative Intervention Study. In Proceedings of the 54th Hawaii International Conference on System Sciences (HICSS 2021) (pp. 1252-1261). University of Hawai'i at Manoa. Proceedings of the Annual Hawaii International Conference on System Sciences. https://doi.org/10.24251/HICSS.2021.152

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VI Kettunen, E., Kari, T., & Frank, L. (2022). Digital Coaching Motivating Young Elderly People towards Physical Activity. Sustainability, 14(13), 7718. https://doi.org/10.3390/su14137718

VII Kettunen, E., Kari, T., Critchley, W. & Frank, L. (2022). Critical Experiences with Sport and Wellness Technology Digital Coach – Differences between Young Adults and Young Elderly. Manuscript submitted for publication to Behaviour & Information Technology journal.

Author contribution

The articles are ordered so that the two articles related to the physically active target group are presented first, following with the two articles related to young adults with low levels of physical activity and finally the two articles related to the young elderly target group. The seventh article combines data from the two latter target groups and is therefore presented last. The articles are also presented in a chronological order (oldest one first) of time of publication, with one exception. Article IV and V have switched, because the articles related to the same target group are presented one after another.

The first author has done the majority of the work in each article. For Articles I, III and V, one co-author conducted the statistical analysis and reported the analysis and some the methodology. Co-authors also assisted with data collection, planning and overall guidance. For Articles II, VI and VII the co-authors assisted with planning and overall guidance.

1 INTRODUCTION

This chapter introduces the background, topic and objective of this thesis, which focuses on digital coaching and how it can support, both psychologically and practically, different types of people in terms of their physical activity.

1.1 Background and Research Environment

Physical activity refers to all movement that a person performs during their leisure or work time. According to the World Health Organization, 25% of adults globally do not meet recommended physical activity levels (WHO, 2020). Physical inactivity is causing health-related problems in terms of overall well-being and physical and psychological health (WHO, 2020). Therefore, it is important to find new ways to promote physical activity on a societal level. There are many regular exercisers who are interested in improving their fitness level, and so there is a demand for effective ways of doing so.

Technology has already been integrated into physical activity, such as through sport and wellness technology. The popularity of sport and wellness technology has recently been rising, and now sport and wellness technology applications and devices are being designed and targeted towards many different types of users with different backgrounds. These devices and applications include heart rate monitors, sport watches, activity bracelets, activity rings, step counters and a range of applications that measure physical activity, nutrition, recovery and even mental health. Sport and wellness technology is utilised by young and old people as well as athletes and beginner exercisers.

For both athletes and beginners, technology has provided an opportunity to receive data to show their performance and development. Data and feedback have proven to be essential in the initial phase of skill acquisition (Winstein & Schmidt, 1990). Being able to compare one's own performance statistics with internally expected optimum performance increases the likelihood of learning

(Liebermann et al., 2002). Using sport and wellness technology has been proven to improve training quality as well as reduce injury risk (Duking et al., 2016). It is also important to remember that different sport technology users have different needs regarding the type and source of feedback. According to previous research, sport technology users appreciate receiving clear information that is easy to understand; they also like to receive information on how to maintain or enhance their physical activity level (Kari, 2017b).

Since the consumer market for sport and wellness technology has become more mature, offering access to lower cost high-quality products, wearable technology and applications has provided an interesting opportunity for human-centred research (James, 2017). Based on previous studies, one of the benefits of sport and wellness technology is providing information on a user's physical activity and exercising, and it has proven to help increase levels of physical activity (e.g. Larsen et al., 2019; Romeo et al., 2019; Vries et al., 2016). Sport and wellness technology has also helped increase awareness of personal physical activity, and so has motivated users to engage in it (e.g. Chan et al., 2004; Faghri et al., 2008; Kari et al., 2017a; Wang et al., 2016). Using sport and wellness technology has been considered helpful for setting goals (e.g. Gordon et al., 2019), and by providing feedback, it can also make users more goal-oriented (e.g. Kari et al., 2016).

Even though sport and wellness technology has been proven to have potential for promoting exercise and physical activity, an increase in personal awareness of it has not always led to sustainable use of sport and wellness technology (Miyamoto et al., 2016). The problem with more traditional sport and wellness technology is that such devices and applications only provide information on previous performances and do not give meaningful guidance or feedback on what to do next. Without personalised information and feedback, it can be easy to interpret information wrongly, especially without professional help, and this may lead to inappropriate adjustments to training (Duking et al., 2016).

One solution for this demand is digital coaching. Digital coaching within the field of sport and wellness technology has been defined in different ways. According to Mezei et al. (2020), 'digital coaching is a system providing the user with actionable advice and feedback to reach fitness goals' (p. 1123). It has also been defined as 'a service on a technological device that not only gives feedback but also offers advice, suggestions and future steps for a user to follow in the pursuit of their wellness and fitness goals' (Kettunen et al., 2018, p. 466) and as 'information technology mediated sports and wellness related coaching activities that are generated by a software without human intervention' (Kari & Rinne, 2018, p. 129). The crucial difference between digital coaching and more traditional sport and wellness technology devices and applications is that a digital coach can provide the user with constantly updated advice and suggestions without requiring human interaction. This feedback is based on the information the digital coach collects or receives from the user. In other words,

the digital coach mirrors the work of a real human coach by providing the user with information and support in the pursuit of their goals.

Kamphorst (2017) listed criteria on how digital coaching can be separated from more traditional coaching technology. The former must have social ability, repeated interactions with the user and be aware of the context, including the user's goals and values. A digital coach must be able to interface with data streams consisting of different types of user data. It also must be personalised and proactive and include some model of behaviour change.

1.2 Sport and Wellness Technology Digital Coaching Research

Digital coaching technology is a relatively rapidly developing concept, and it therefore makes an interesting topic for research. Despite its newness, the concept of digital coaching has already been applied to other fields outside sport, wellness and health. Previous research has used digital coaching in fields such as personality change (Allemand & Flückiger, 2022), self-control (Allemand et al., 2020), knowledge mobilisation (Karlsson, 2018), changing personality traits (Stieger et al., 2021) and strategic investment (Kinnunen & Georgescu, 2021). Digital coaching has also been referred to as virtual coaching (e.g. Blok et al., 2017), electronic or e-coaching (e.g. Adams & Niezen, 2016; Chatterjee et al., 2021) and as smart coaching (Diaz et al., 2020). From here onwards in this thesis, the term *digital coaching* specifically refers to digital coaching within the sport and wellness context.

In previous research, the concept of digital coaching has often been discussed within the context of health, wellness and sport. In their scoping review, Lentferink et al. (2017) found 17 studies that used digital coaching in relation to physical activity and health. The most common features included in digital coach solutions were suggestions, goal setting, simulation and reminders. These studies suggested that digital coaching can have a positive influence on health outcomes by, for example, personalising goals, creating short-term goals to reach longer-term ones, giving praise messaging, integrating self-tracking technology and sending reminders. Another literature review of digital coaching by Chatterjee et al. (2021) found 53 studies related to digital coaching and behavioural interventions. They found that the most appropriate processes for digital coaching were personalisation, interaction and co-creation, behaviour change techniques, goal-setting, evaluation and persuasion. According to the studies, the key-component for positively influencing adherence and usability was personalisation (Chatterjee et el., 2021; Letferink et al., 2017). Mezei et al. (2020) also highlighted the importance of personalisation when designing digital coaching solutions and emphasised the individualisation of goals and exercise programmes. However, based on their results, feedback and social functionalities did not play a meaningful role in users' perceptions of digital coaching. In addition, digital coaches have to be easily adjustable, customisable and easy to understand (Benítez-Guijarro et al., 2018; Chatterjee et al., 2021)

According to Diaz et al. (2020) digital coaching solutions, in addition to research related to digital coaching and physical activity, has become more popular in the past decade. Sport and wellness technology digital coaching solutions have so far been focused on technical aspects that aim to make movements and techniques more efficient and predictable. For example, digital coaches have been developed for specific sports such as weightlifting, tai chi and cycling (Kamel et al.; Silacci et al., 2019; Yasser et al., 2019). Few current sport and wellness technology digital coaches focus on motivational aspects. Users are more engaged with sport and wellness technology devices when they are involved in activities related to psychological needs of competence, autonomy and relatedness (Chang et al., 2016; Molina & Sundar, 2020; Sundar et al., 2012).

Designing digital coaching involves a complex process that demands careful planning by experts across different fields, including computer science, psychology and medical science. In order to serve the user comprehensively, a digital coach should collect physiological, behavioural and emotional data from them. Digital coaching solutions also need to be targeted appropriately to different groups by implementing suitable persuasive strategies and behaviour change techniques (Petsani et al., 2018). Broekhuizen et al. (2016) found that digital coaching can be suitable for elderly people by helping them achieve their physical activity goals. It seems that demographics like gender, general health state and age do not influence the perception of digital coaching. However, general attitudes towards health coaching can influence perceptions of digital technology, as can attitude and readiness to embrace it (Volkova-Volkmar et al., 2016). According to Sell et al. (2019), physical activity level can influence attitudes to digital coaching, so that people with higher levels of physical activity show more interest in digital coaching and its features.

Previous literature has also compared digital coaching to human coaching. Human coaching has been associated with problems such as bias, conceptual clarity, freedom of expression pressure and language. Chatterjee (2021) suggested that digital coaching can potentially overcome these problems and may also increase coaching's perceived level of flexibility and accessibility.

Despite the current trend, the area of sport and digitalisation is still an understudied topic in the field of information systems (IS) (Xiao et al., 2017). Future research needs to consider many different aspects of digital coaching and how it can be combined in studies across several research fields (Diaz et al., 2020). Additionally, few digital coaching studies have taken a sport and exercise psychology perspective. According to previous research, the benefits from digital coaches are limited mainly to exercise tracking and user data visualisation. Further studies are therefore needed, especially to understand how digital coaching can be related to promoting intrinsic motivation (Helmefalk et al. 2020) and to further investigate digital coaching functionalities that are designed to promote behavioural change and increase exercise motivation (Sell et al., 2019)

This thesis aims to broaden the research on digital coaching in the context of sport and wellness technology and address the research gap by tackling the topic from both an IS point of view and an exercise psychological perspective. By

identifying how people perceive using the digital coaching technology available currently and understanding how it motivates and supports its users, it is possible to identify how digital coaching can serve them even better in the future.

1.3 Objectives and Scope

Even though there are studies on the motivational effects of sport and wellness technology on exercise motivation, the body of research on sport and wellness technology digital coaching is still relatively small. This thesis looks at the topic from the perspective of exercise psychology and information technology and focuses on the motivational influence of digital coaching on physical activity as well as on its form factor and individuals' usage experiences.

This topic is examined from an exercise psychological point of view because in exercise and sport, self-efficacy beliefs are important in fostering behavioural and motivational outcomes (Beauchamp et al., 2019). This core belief also influences processes of personal change and regulates human motivation, behaviour and well-being (Bandura, 2004). Therefore, it is important to study from a sport and exercise psychological point of view whether using a digital coach can influence a user's self-efficacy or motivation and assist them in achieving and maintaining a more physically active lifestyle.

Since digital coaching technology in the sport and wellness technology field is still relatively new, this thesis also focuses on understanding different types of users' usage experience of digital coaching. The aim is to provide insight into how sport and wellness technology digital coaches as proxy agents currently support their users in physical activity and how they could serve even better in the future. This more practical point of view looks at the topic from an IS perspective by focusing on the interaction different users have with a digital coach. It also highlights the suggestions for future development of digital coaches.

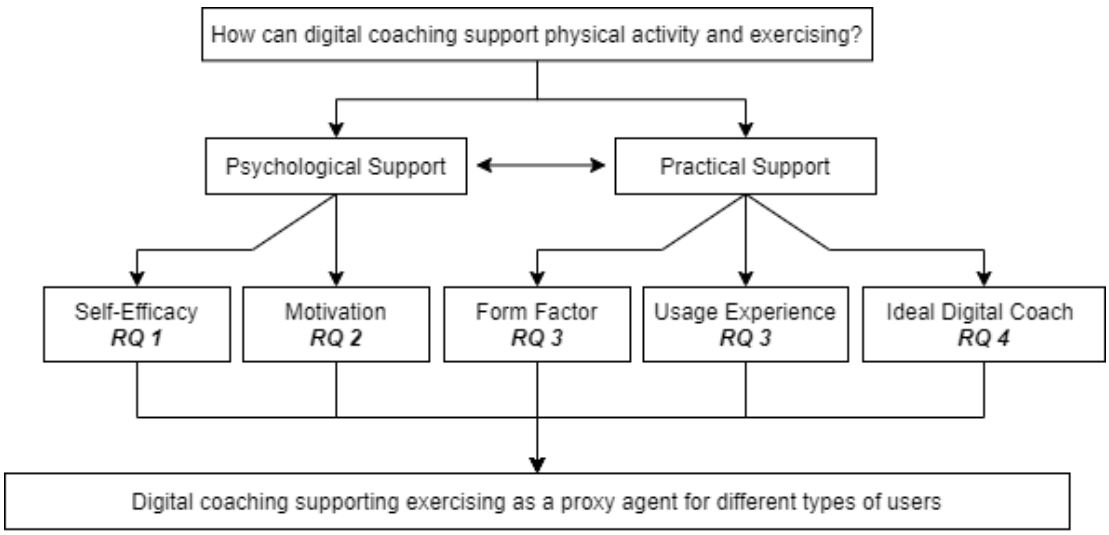

FIGURE 1 Thesis' research scope: Digital coaching supporting physical activity

As seen in Figure 1, the digital coaching support has been divided into two parts in this thesis: psychological support and practical support. Whereas the psychological part focuses more on exercise psychology, the practical part focuses on digital coaching more from an IS point of view. The psychological and practical support have been divided into sub-sections that are considered essential for the study. The focus of this thesis is to identify answers to these sub-sections by addressing the following research questions:

RQ1 How can digital coaching influence exercise self-efficacy?
RQ2 How can digital coaching influence exercise motivation?
RQ3 What experiences do people have when using digital coaching to support exercising?
RQ4 What are the ideal characteristics of a sport and wellness technology digital coach?

This thesis answers the above questions by gathering together the content of seven research articles (Articles I–VII). The thesis includes different intervention studies, each of which has resulted in two separate articles. The intervention study participants were 1. physically active (people with high levels of physical activity), 2. young adults with low levels of physical activity and 3. young elderly people, which refers to people ages between 60-75 (Carlsson & Walden, 2016). Additionally, the most recent article (Article VII) used data from two different interventions, namely young adults with low levels of physical activity and young elderly people, to investigate critical incidents related to the usage of digital coaching.

When planning and analysing behaviour change systems, such as digital coaching in this case, it is important to study a topic using different user segments to a gain deeper understanding (Oinas-Kukkonen, 2013). The purpose of these interventions was to study the same phenomena using three different user groups. The reason of having these three user groups was to study digital coaching among people who have different types of physical activity backgrounds and levels as well as age groups. The intervention studies are:

Study 1. This intervention study included physically active people of all ages who were recreationally competitive.

Study 2. This study comprised younger people who were physically less active and did not meet suggested limits of physical activity, namely either 2 h 30 min of moderate exercise or 1 h 15 min vigorous exercise per week (UKK Institute, 2020).

Study 3. This study was conducted among young elderly people, and the target group consisted of both physically active and less active participants.

By selecting these three target groups, the purpose was to attain data from different types of users, thereby ensuring that the results were not applicable to any one target group, age group or group with a certain physical activity background.

All three intervention studies followed a similar structure, although the intervention length was increased for Studies 2 and 3, after the results had been obtained from Study 1. This increase was done based on the feedback received from the participants in the Study 1. Additionally, because the studies were in different contexts, the digital coach in Study 1 was different to the digital coach used in Studies 2 and 3. This was done so that the digital coaches would be suitable for each target group, and because one type of digital coach could not serve all three target groups. Study 1 focused on a specific competitive event, while studies 2 and 3 focused on general fitness and lifestyle.

The following paragraphs detail the research questions and the articles they correspond to. There is also a brief description of the aims of each research questions.

RQ1— Articles I, III and V. This research question focuses on self-efficacy. As stated above, levels of physical activity decrease among different types of people. Self-efficacy plays an essential role in human behaviour and actions and also in terms of physical activity and exercising; therefore, it was chosen to be the concept to study further. No matter the age or level of the current physical activity, higher exercise self-efficacy can motivate people to reach their goals, whereas lower exercise self-efficacy can demotivate or discourage them from trying. These three articles studied whether using a digital coach influenced different types of users' self-efficacy. The articles also highlighted the way in which a digital coach could influence their self-efficacy. All three articles used quantitative research methods. Some qualitatively collected answers related to self-efficacy from Articles II, IV and VI also partially answer RQ1.

RQ2 — Articles II, IV and VI. For this research question, the topic of digital coaching continued to be studied from an exercise psychology point of view. The aim was to identify by qualitative methods how using the digital coach could influence different people and their exercise motivation. For this research question, the focus was not on studying the levels of extrinsic or intrinsic motivation but on the components of self-determination theory (autonomy, competence, relatedness) that are often linked to motivation.

RQ3 — Articles II, IV, VI and VII. This research question focuses on the form factor of a digital coach and its usage experience. The aim of the articles was to better understand how different people perceived using a digital coach and what they liked or disliked about it. Special focus was placed on experiences related to the usage of adaptive training guidance and real-time feedback.

RQ4 — Articles II, IV, VI and VII. This research question looks at the concept of digital coaching in general. The focus of the studies was to find users' suggestions, wishes and even demands related to the further development of digital coaches. These answers would provide better insight, for instance to sport and exercise technology companies, into how to develop digital coaching in the future.

2 THEORETICAL FOUNDATION

The theoretical foundation of this thesis is based on theories linked to exercise motivation. Motivation can be defined as the intensity and direction of one's efforts (Weinberg & Gould, 2011). It plays an important role in supporting exercising and physical activity and is associated with important outcomes related to health and well-being (Teixeira et al., 2013). The theories that are linked to motivation and included in the theoretical framework of this thesis are self-efficacy theory, self-determination theory (SDT) and the theory of proxy agency. Self-efficacy and self-determination play an essential role in exercise motivation and were therefore selected as theories for the thesis. Proxy agent theory provides a platform for digital coaching and is used in this thesis as a digital personal trainer for physical activity and exercise. These three theories are presented in later sections.

The theories are also familiar in IS research. For example, the concept of self-efficacy has been studied in many different contexts, such as in terms of computer self-efficacy (Compeau & Higgins, 1995), IS security (Hameed & Arachchilage, 2021) and technology acceptance (Levy & Green, 2009). SDT has been associated with studies related to motivational information systems that have often focused on gamification, such as in the field of sport and exercise education (Koivisto & Hamari, 2019). Also, proxy agent theory has been used in research fields such as human–computer interaction (DePaula, 2003), organisational studies (Alavi & McCormic, 2016), exercise psychology (Shields & Brawley, 2006) and physical activity (Bray & Shields, 207).

Among the alternative theories that could have been integrated into this thesis is the technology acceptance model (Davis, 1989), which is often used in IS research when studying how users accept and use technology. However, the theoretical scope was built on psychological theories that are used across multiple research fields, such as physical activity, exercise psychology and information systems.

2.1 Self-Efficacy Theory

The theory of self-efficacy derives from Bandura's (1986) social cognitive theory. Self-efficacy refers to a person's beliefs about their ability to perform a certain task. A person with high self-efficacy often perceives difficult tasks as challenges and opportunities, but a person with low self-efficacy might perceive them as negative and try to avoid them (Bandura, 1986). It is important to distinguish the difference between a person's actual ability to perform a task and their perceived ability to do so, since these can be different. The concept of self-efficacy focuses on perceived capabilities.

According to Bandura (1982, 1986, 1994), self-efficacy can be influenced by four different essential factors, namely performance accomplishments, vicarious experiences, verbal persuasion and psychological states. Performance accomplishments mean mastery experiences; that is to say, previous personal experience of performing a task and having improved or learned something from it. These accomplishments amount to the most important and influential factor regarding self-efficacy. Vicarious experiences refer to observing other people and learning from their experience. Verbal persuasion refers to feedback and comments received from other people. Finally, psychological states refer to perceived emotional arousal and how it influences the perception of performing a task.

Physiological indicators of self-efficacy have an essential role, especially when related to health functioning, physical activity or athletic performance (Bandura, 1994). It is not necessarily the intensity of the physical and emotional reactions but the interpretation of those reactions that makes a difference. Exercisers and athletes who have high self-efficacy view their physical reactions as energising facilitators of their performance, while people with low self-efficacy often associate those physiological indicators with self-doubt. (Bandura, 1994).

The concept of self-efficacy was adopted for this study because it is a widely used theory and one of the most researched concepts in physical activity (Kroll et al., 2007) and sport performance (Feltz, 1988). Self-efficacy is also a fundamental variable for predicting and understanding health-related behaviour (Hevey et al., 2012). It can be both an effect and a cause of performance (Moritz et al., 2000). Self-efficacy has a significant influence on the adaptation of physical activity habits and the maintenance of long-term physical activity (McAuley et al., 2000; Warner et al., 2014). People with high self-efficacy may therefore work harder and participate more frequently in physical activity (Bandura, 1986). According to previous research conducted among elderly people, a boost in exercise self-efficacy will lead to greater exercise adherence (McAuley et al., 2011), and high self-efficacy is also related to the maintenance of physical activity (Neupert et al., 2009).

Self-efficacy has an important role in sport by influencing the selection of the activity, persistence level, effort expenditure and vulnerability to depression and stress (Bandura, 1997). When it comes to sport, high self-efficacy has also

been linked to strong goal importance, high personal goals, low pre-competition anxiety and high trait sport confidence (Feltz & Lirgg, 2001).

Self-efficacy is also an important topic when talking about technology use, as a person's self-efficacy in terms of using technology can influence their behavioural and evaluative response to the product or service (Ellen, 1991). In this thesis, the topic of self-efficacy focuses more on exercise self-efficacy, although it was briefly discussed in terms of using new technology during the interviews, and the most significant results concerning it are reported.

2.2 Self-Determination Theory

The theory of self-determination (SDT) by Ryan and Deci (2000) is often highlighted when discussing motivation. SDT is an empirically derived theory of human motivation focusing on personality development and behavioural self-regulation (Ryan & Deci, 2000). The theory categorises motivation into intrinsic and extrinsic motivation. Intrinsic motivation refers to 'doing an activity for the inherent satisfaction of the activity', whereas extrinsic motivation refers to 'the performance of an activity in order to attain some separable outcome' (Ryan & Deci, 2000, p. 71). Extrinsic motivation is derived from other people through negative or positive reinforcement, whereas intrinsic motivation is linked to a desire to be competent and master a task (Weinberg & Gould, 2011).

Intrinsic motivation is important and often the desired type of motivation. According to SDT, intrinsic motivation includes three components that influence motivation, namely the need for autonomy, for competence and for relatedness. The need for autonomy corresponds to a person's need to be able to self-regulate their own behaviour. The need for competence refers to a person's need to complete a task by interacting effectively with the surrounding environment. The need for relatedness means a person's need to be able to interact with others (Ryan & Deci, 2000). The feelings of competence, autonomy and relatedness can together or separately facilitate intrinsic motivation, thereby having a positive influence on motivation through increased levels of self-determination (Carron et al., 2003). Intrinsic motivation is autonomous, so that the motivation comes from the behaviour itself, whereas extrinsic motivation refers to behaviour whereby an activity or a task is performed in order to attain a desired consequence (Deci et al., 2017)

The theory of self-determination is also frequently applied in the exercise domain (Duncan et al., 2010). In general, intrinsically motivated people, especially when talking about physical activity, consider an activity to be more enjoyable in the long term (Ryan et al., 2009). Intrinsic motivation has also been related to forming and maintaining exercise habits and a more physically active lifestyle. Whereas an extrinsically motivated exerciser may receive motivation from rewards or fame, an intrinsically motivated exerciser takes their motivation from performing an exercise or participating in a competition. Most exercisers or athletes are motivated by both intrinsic and extrinsic motives (Ryan et al., 1997).

The most common motives for adults to start exercising are extrinsic factors such as weight loss, increased fitness or improved health; however, exercisers with more intrinsic motivation are more likely to keep up with their motivation (Carron et al., 2003).

In this thesis, the goal is not to study possible changes in participants' intrinsic or extrinsic motivations. Instead, since the topic of motivation is generally very broad, the research focus has been narrowed to studying how using a digital coach can influence a person's feeling of competence, relatedness and autonomy, thereby facilitating intrinsic motivation for physical activity and exercise.

2.3 Proxy Agent Theory

Another theory derived from Bandura's social cognitive theory is the concept of 'proxy agency' (Bandura, 1982). According to Bandura, agency refers to a person's ability to influence the surrounding world through their actions. People use proxy agents to assist in their self-renewal, self-development and adaptation to the demands of life. There are three different types of agents: personal, collective and proxy. Whereas in personal agency, a person acts as an agent, in the case of a collective agency, a group of individuals act together as an agent. In the case of proxy agency, a person uses a third party to act as an agent on their behalf (Bandura, 1982).

According to Bandura, there are three reasons why a person uses a proxy agent. First, a person might feel that they do not have the knowledge or skills needed to reach a desired goal and therefore want to hand over control to someone else. Second, even though a person might have the necessary skills and knowledge, they may give control to someone else who they perceive being more capable of bringing themselves close to the desired goal. Third, a proxy agent could be seen as a suitable option just because a person wants to shift responsibility to someone else despite having all the necessary skills and knowledge (Bandura, 1997).

In a physical activity setting, the use of a proxy agent can refer to having a coach or a personal trainer. The role of the proxy agent is to help the person manage demands related to the environment and different tasks and to provide help in controlling exercise behaviour, managing lifestyle and developing new skills (Beauchamp & Eys, 2007). In addition, guiding and managing a proxy agent can provide social support. Such support can lead to increases in focus, enjoyment and involvement (Jowett & Lavallee, 2007), which can in turn result in positive experiences and therefore increased motivation. Coaches and personal trainers also influence a person's self-efficacy by providing vicarious experiences and using persuasive techniques such as verbal persuasion, stating their expectations and providing feedback.

In this thesis, the digital coach is viewed as a proxy agent, as its role is to help the user by facilitating improvement related to physical activity and well-

being. The digital coaching feature of a sport and wellness technology device replicates a human coach by offering and modifying an individualised training plan based on the constantly changing data received from the user. In addition to providing a training plan, the digital coach gives the user individualised feedback about their performance as well as encouragement to continue forward.

It has previously been highlighted that using a proxy agent for a longer period of time may lower the user's self-regulatory skill, causing them to feel less capable of managing their behaviour independently (Shields & Brawley, 2006). Low self-regulatory skills are also associated with low exercise adherence (Hagger et al., 2010). However, these results were found in studies that focused on human proxy agents. Using a digital coach requires some level of independence and regulatory skills and gives more responsibility to the user.

Rather than being tested in the individual studies, the proxy agent theory is used in this thesis to create a platform for digital coaching and its usage. However, by analysing the results of the thesis, is possible to gain an understanding of the kind of proxy agent a digital coach may be and what its benefits are, for example, compared to a human proxy agent.

3 RESEARCH METHODOLOGY

This chapter presents the research methodology used in this thesis. The chapter begins with an introduction to the research approach, which is followed by an overview of the digital coaching devices and application used in this study. After this, the focus is on data collection, whereby the details of each individual study are explained separately. The chapter ends by introducing the data analysis methods.

3.1 Research Approach

Research approaches are often divided between inductive and deductive approaches. In the inductive research approach, the goal is not to test a theory but to focus on a phenomenon and generate explanations and theories. In contrast, in the deductive approach, the goal is to test a hypothesis that is often derived from a theory or a hypothetical construct (Wilson, 2014). The research approach followed in this thesis is mainly inductive (Articles II, IV, VI and VII) but also has some deductive elements (in Articles I, III and V).

Epistemology refers to the criteria that are used for evaluating and constructing knowledge. Studies can be classified into three different approaches based on the epistemology, namely *positivist*, *interpretive* and *critical* studies. Positivist studies usually attempt to test a theory to increase the understanding of phenomena. In positive studies, there is usually already a fixed relationship with the phenomena, and these studies are often conducted with quantifiable measures. In critical studies, to idea is look at already existing phenomena or assumptions critically to find contradictions. In interpretive studies, the researcher aims to understand phenomena by assessing meanings taken from the participants. The goal is to find a deeper understanding that can then be used to inform other settings. (Myers & Avison, 2002) This thesis contains an interpretive approach. Whereas epistemology provides an approach for constructing knowledge, Ontology refers to the form and nature of reality. Interpretive IS

research assumes that the social world is not given but rather it is reproduced and reinforced by human actions and interactions (Myers & Avison, 2002).

Research methodology focuses on how to generate appropriate evidence. Since this thesis includes both quantitative and qualitative studies, a mixed methods research methodology is used. The quantitative part of the studies follows a quasi-experimental research design where the aim is to test, by using an intervention and control group, whether using a digital coach to support physical activity and exercise can influence the users' self-efficacy and attitude. The qualitative part of the studies follows an interview-based design where the aim is to find out more specific information on how and why a digital coach can influence their physical activity and exercise. As proposed by Dennis and Valacich (2001) it may be possible to combine experimental research with both quantitative and qualitative analyses to provide more comprehensive and deeper understanding of IS phenomena.

3.2 Digital Coaches Used in the Studies

It was intended that a single digital coach would be used across all three studies—one that would be considered useful and interesting by the users of each target group. However, since the demography and physical activity backgrounds varied so much between the different target groups, it was impossible to use a single digital coach across all the studies. Therefore, two different digital coaching solutions were chosen. Figure 2 illustrates the two digital coaches used, namely the Racefox Ski application (left; Racefox, 2022) and the Suunto 3 Fitness watch (right; Suunto, 2022).

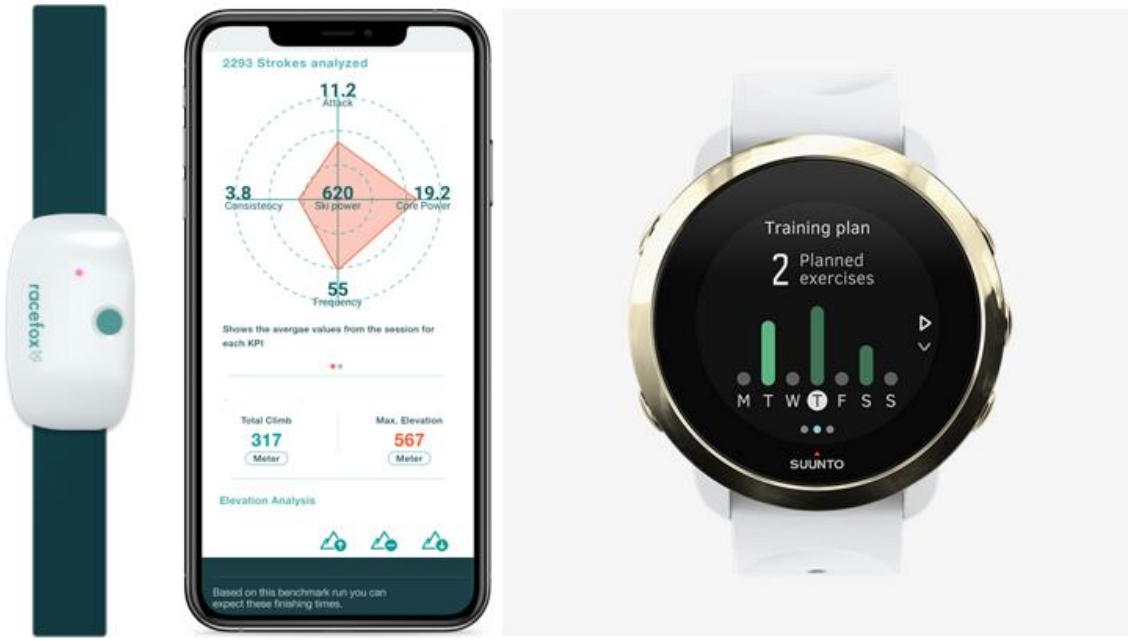

FIGURE 2 The digital coaches used in this thesis

In Study 1 (Articles I and II), conducted among physically active people, the digital coach given to the participants was the Racefox Ski application. At the time of the study, it was one of the only digital coaching solutions designed especially for cross-country skiing and therefore was suitable for the physically active target group, particularly since the participants had been recruited among skiers. The product includes a chest strap sensor and a phone application. Besides heart rate, the chest strap measures the user's movements and provides key performance indicator values such as core power, frequency, attack and consistency, which are all related to classic style cross-country skiing. The user receives the information through a smartphone application. The digital coach then provides feedback on the user's skiing style and provides suggestions on how to make it better. The feedback is given in real time or at the end of the exercise. Besides providing feedback after training, the digital coach also designs specific cross-country skiing training plans for the user to follow. The user may also create their own training plan.

The digital coach used in the Study 2 (Articles III and IV) and Study 3 (Articles V and VI) was the Suunto 3 Fitness watch, which was considered suitable for young elderly participants as well as for young adults with low levels of physical activity. The watch, which has a wrist-based heart rate sensor, is designed to monitor factors such as sleep, daily physical activity, heart rate, stress and recovery. The information can be read from the watch itself or from a smartphone application linked to the watch. This specific watch was chosen for the study because of its 'adaptive training guidance' and 'real-time feedback'. The adaptive training guidance creates an individual training plan for its user based on the data the watch has collected from that user. It also updates the training plan after every workout based on the user's performance in the previous workout. The digital coach plans, for example, the training duration and intensity, whereas users can decide for themselves how they want to perform the exercises. This feature is designed for endurance exercising, such as walking, running and biking, but it is not less suitable for activities such as gym training and team sports. The digital coach provides real-time feedback during the training, making sure that the user is performing the exercise at the right intensity level.

3.3 Data Collection

All the data for the articles presented in this thesis were collected between January 2018 and August 2019 using two longitudinal quasi-experimental designs. Data was collected to examine three different groups: physically active people, young adults with low levels of physical activity and young elderly people. All three studies included both qualitative and quantitative data collection and followed a similar structure; that is to say, they had an intervention/experimental group and a control group. The participants were voluntary and were randomly allocated into two groups (intervention and

control groups). The intervention group participants were given a sport and exercise digital coach to use for the duration of the intervention. Each of the three studies produced two individual articles. An additional article was written that used the data from Studies 2 and 3.

The quantitative data were collected from an online questionnaire at the beginning and the end of the study period. In Studies 2 and 3, quantitative data were also collected halfway through the study period. This is because the intervention length in these studies was a few weeks longer than it was in Study 1. The online questionnaire was the same at all data collection points throughout each of the studies. The purpose of the questionnaires was to assess whether there had been any changes regarding the investigated outcomes, including self-efficacy or opinions related to digital coach usage during the intervention period. The quantitative survey data were collected using the Limesurvey online questionnaire platform. More information about questionnaire can be found from the following sections.

The qualitative data were collected at the end of each study period in the form of semi-structured interviews. Compared to a structured interview, a semi-structured interview does not have a complete script but rather a pre-formed structure for the interviewer to follow (Myers & Newman, 2017). The purpose of the interviews was to gather views on using a digital coach as well as more detailed information on how a digital coach can support the user in achieving their physical activity goals. The purpose of the interview was also to collect ideas and suggestions about how to improve digital coaching in general. In Study 1, additional qualitative data were collected via a short, open-ended online questionnaire.

3.3.1 Study 1: Physically Active People

This study produced material for Articles I and II. The data collection for the study took place between February and April 2018. The target audience of Study 1 comprised physically active people who had been recruited among cross-country skiers preparing to take part in the Neljän Vuoren Hiihto cross-country skiing marathon event in Jyväskylä, Finland, on 10 March 2018. The digital coach used in the study was the Racefox Ski (Racefox, 2022) application. The skiers had the choice of participating either in a 50 km or a 30 km race. In total, 40 skiers who had signed up for the event expressed an interest in the study. Of them, 25 were selected for the intervention group and 15 for the control group. The goal was to have equal representation in both intervention and control groups in terms of the gender of the participants. The main selection criterion for the test group was the skiing style that participants would use in the upcoming ski marathon. Since the digital coach was designed to provide feedback and design training plans related only to classic-style skiing, the intervention group could only include participants who would ski the race in classic style. The control group participants would ski the race using either the classic or the skating style. Therefore, only the classic style skiers were randomly distributed between the intervention and control groups. Since two participants in the intervention group

experienced technical problems using the digital coach with their mobile phone, they were excluded from the quantitative part of the study.

The quantitative data were collected through two online surveys before and after a 5-week period that took place just before the ski race. The second round of data collection was conducted before the ski race so that the results of the race or the overall race experience would not affect the data. The survey included 30 items that measured self-efficacy related to overall skiing ability and upcoming race performance. The wording of the questionnaire items was adapted from a self-efficacy scale by Sâmija et al. (2016) modifying the context to skiing and skiing technique. The items were not intended to measure a specific broader construct related to self-efficacy even though some items shared common themes. Therefore, the responses were examined on an item level rather than a construct level. Additionally, the survey included questions related to attitude towards digital coaching. These questions were created using the studies of Kari and Makkonen (2014) and Taylor and Todd (1995) as examples.

The qualitative data collection was performed via a short online questionnaire a few days before the race. The purpose of the questionnaire was to collect information related to race preparation and the participants' overall feelings relating to the upcoming race. The more significant data regarding the qualitative part of the study was done via interviews at the end of the study, after an approximately 8-week digital coaching usage period. Table 1 shows the physical activity backgrounds of the participants. The categorisation is based on Finnish National Sport Survey (Finnish Sports Federation, 2011) and includes seven different activity classes.

TABLE 1 Descriptive statistics of the participants: Physically active people

	Whole sample (N = 38)	**Intervention group (N = 25)**	**Control group (N = 15)**
Gender			
Male	20	12	8
Female	20	13	7
Age			
21–30 years	7	3	4
31–40 years	10	6	4
41–50 years	13	9	4
51–60 years	6	5	1
61–70 years	3	1	2
71-80 years	1	1	
Skiing distance			
30 km	11	2	9
50 km	29	23	6
Skiing style			
Classic	33	25	8
Skate	7	0	7
Physical activity background			
Competition athletes	8	4	4
Fitness athletes	22	14	8
Fitness participants	10	7	3
Physically active for health	0	0	0
Active in commuting and non-exercise	0	0	0
Occasionally active	0	0	0
Sedentary	0	0	0

3.3.2 Study 2: Young Adults with Low Levels of Physical Activity

This study produced material for Articles III, IV and VII. The study was conducted among people who had low levels of physical activity. Since the goal was to find young adults as participants, participant recruitment took place among university students with low levels of physical activity. This study used the Suunto 3 fitness watch as a digital coach (Suunto, 2022). In terms of the physical activity, participants who did not meet the recommended minimum level of physical activity (i.e., 2 h 30 min moderate exercise or 1 h 15 min vigorous exercise per week) of the Finnish UKK Institute (UKK Institute, 2020) were selected. The study included 60 participants divided randomly into two equal sized groups, and the aim was to have as equal groups as possible in terms of gender and age. The participants were between the ages of 21 and 53 years. However, since the majority of the students were under 40 years old it is possible to call the participant group as young adults. During the intervention, one control group participant wanted to drop out because of issues related to their health and therefore the final number of participants ended up being 59.

The data collection for the study took place between October 2018 and January 2019. The quantitative data were collected via online surveys at the beginning, at halfway and at the end of the 10-week intervention. The survey questionnaire included the self-efficacy scale by Kroll et al. (2007) and 13 additional items that measured self-efficacy related to general beliefs about exercising and using sport and exercise technology during training. The self-efficacy questionnaire by Samija et al. (2016) was used as a model for these additional items. Additionally, the survey included questions related to attitude towards digital coaching. These questions were created using the studies of Kari and Makkonen (2014) and Taylor and Todd (1995) as examples. All the items in the survey were examined at an item level, instead of looking at them at a construct level. By examining the survey at an item level, it was possible to gain valuable information about what types of self-efficacy had increased or decreased. The qualitative data were collected via individual semi-structured interviews that took place at the end of the intervention. The interview script included the following sections: background information, expectations for digital coaching, user experiences, adaptive training guidance and real-time feedback, effects of the digital coach on exercising and ideal digital coach. Questions specific to self-efficacy and motivation were included in the interview script. Table 2 shows the physical activity backgrounds of the participants.

TABLE 2 Descriptive statistics of the participants: Young adults with low levels of physical activity

	Whole sample (N = 59)	**Intervention group (N = 30)**	**Control group (N = 29)**
Gender			
Male	17	10	7
Female	42	20	22
Age			
< 25 years	14	8	6
25–30 years	18	8	10
31–35 years	11	6	5
36–40 years	7	5	2
40< years	9	3	6
Degree under study			
Bachelor's degree	16	8	8
Master's degree	39	20	19
Doctoral degree	4	2	2
Study mode			
full-time student	40	21	19
part-time student	15	7	8
other	4	2	2
Physical activity background			
Competition athletes	0	0	0
Fitness athletes	0	0	0
Fitness participants	8	0	8
Physically active for health	8	4	4
Active in commuting and non-exercise	24	17	7
Occasionally active	19	9	9
Sedentary	2	1	1

3.3.3 Study 3: Young Elderly

This study produced material for research Articles V, VI and VII and focused on young elderly people and digital coaching. In this study, the definition of *young elderly* was people aged 60 years and older. The data collection was carried out between June and August 2019. This study used the Suunto 3 fitness watch as a digital coach (Suunto, 2020). The structure of this study was exactly the same as that of Study 2 (see Section 3.3.2), which was conducted among young adults with low levels of physical activity. However, the criteria for choosing the participants were different; when choosing young elderly participants, the selection criterion was the person's age, instead of their physical activity background. Altogether, 62 participants volunteered for the study, of whom 30 were randomly selected for the intervention group, and the remaining 32 for the control group. The aim for this study was also to have equal groups in terms of gender. As with the previous study, the intervention lasted 10 weeks with three data collection points, and it was followed by a semi-structured interview, either individually or in pairs, at the end of the intervention. Table 3 shows the physical activity backgrounds of the participants.

TABLE 3 Descriptive statistics of the participants: Young elderly people

	Whole sample (N= 62)	**Intervention group (N=30)**	**Control group (N=32)**
Gender			
Male	22	10	12
Female	40	20	20
Age			
61–65 years	17	7	10
66–70 years	26	15	11
71–75 years	16	7	9
76–80 years	3	1	2
Socioeconomic status			
Working	4	2	2
Retired	57	28	29
Other	1	0	1
Physical activity background			
Competition athletes	0	0	0
Fitness athletes	4	2	2
Fitness participants	22	11	11
Physically active for health	25	11	14
Active in commuting and non-exercise	9	4	5
Occasionally active	1	1	0
Sedentary	1	1	0

3.3.4 Critical Incident Technique

The critical incident technique (CIT; Flanagan, 1954) was used in Article VII. A critical incident was described by Edvardsson and Roos (2001, p. 253) as an experience that a person 'perceives or remembers as unusually positive or negative'. Based on previous research, critical incidents have a significant role in forming users' perceptions towards products or services and their providers (Edvardsson & Strandvik, 2000; Payne et al., 2008). Critical incidents are highly influential for human behaviour (Flanagan, 1954). For example, a single critical incident can overrule a set of average positive incidents, leading a user to discontinue the usage of the product or service (Kari et al., 2020; Salo & Frank, 2017). According to Gogan (2014), CIT is a useful but underutilised research method in IS and provides strong findings. It is used extensively in research related to other disciplines, such as marketing and psychology.

The data for Article VII were taken from the studies conducted with young adults with low levels of physical activity and young elderly people. Even though usage experience had already been studied in Articles IV and VI, Article VII was written to focus exclusively on the critical incidents that could have influenced the overall usage experience with the digital coach. CIT was chosen as an appropriate approach, since it provides highly contextualised accounts of individuals' influential incidents with IS (Gremler, 2004; Meuter et al., 2000)

The model for structuring the interview questions regarding CIT was taken from widely cited CIT papers by Bitner et al. (1990) and Meuter et al. (2000). All participants were asked to think of a time when they had had a notably positive or negative experience related to using the digital coach. Participants were asked to describe the situation in as much detail as possible and explain what exactly had caused the feeling of positivity or negativity. Participants were also asked to describe why this experience was significant to them and whether and how it had affected their further usage of the digital coach. Lastly, the participants were asked to describe the feeling attached to the experience.

3.4 Data Analysis

This thesis includes both quantitative and qualitative analysis methods. Quantitative statistical analysis was used in Articles I, III, and IV, whereas qualitative analysis was used in Articles II, IV, VI and VII. This section briefly introduces the use of both analysis methods. However, more information can be found from the articles.

3.4.1 Quantitative Data Analysis

The quantitative analysis method was used in Articles I, III and V. Employing two longitudinal quasi-experimental designs changes in self-efficacy and attitude related to exercising and digital coaching were measured. This was with the aim

to find out how using a digital coach can influence self-efficacy. In all these articles, quantitative analysis was performed in the same way; that is to say, using IBM SPSS Statistics 24 software. Because of the non-normal distribution across some items and the small sample size, the non-parametric Wilcoxon (1945) test was used to analyse changes between the measurements. The threshold for statistical significance was $p < 0.05$. Since the survey questions were mostly not intended as a specific broader construct of self-efficacy, all the questions across the three studies were examined at an item level. The potential missing values were handled such that the answers of a particular participant to a particular item were excluded in the event that they had not provided an answer to that item in all the questionnaires. Therefore, the exact number of respondents may vary slightly by each item.

3.4.2 Qualitative Data Analysis

In Articles II, IV, VI and VII, a qualitative analysis method was used to gain insight into the usage experience of digital coaching and its motivational influence. Similar to the quantitative articles, all the qualitative articles used the same qualitative analysis method, namely thematic analysis, which is one of the most widely used qualitative research analysis methods (Guest et al., 2012). According to Braun and Clarke (2006), thematic analysis is used for 'analysing, identifying and comparing patterns within data' (p. 79). In the analysis, the guidelines and steps of Braun and Clarke (2006) were followed. These steps were as follows: (a) familiarisation with the data, (b) generating initial codes, (c) searching for themes, (d) reviewing themes, (e) defining and naming themes and (f) producing the report. These guidelines were adjusted to best fit the research aim of the study. In the analysis phase, a recursive process was used, since it allowed moving back and forth between different analysis phases and therefore helped provide a deeper understanding and analysis of the data

The analysis process of the studies began with becoming familiar with the data and transcribing the relevant parts of the interviews. In the interview phase, the interview themes were already divided into smaller sections. In Article II, these themes were background information, expectations about digital coaching, user experience, race preparation, digital coaching in general and ideal digital coaching. In Articles IV and VI, the themes were background information, critical incidents, expectations about digital coaching, usage of the digital coach, adaptive training guidance and feedback, effects on behaviour and motivation, digital coaching in general and ideal digital coaching. Questions related to self-efficacy, motivation and usage experiences were present in many interview themes. This is because the interviews were semi-structured, allowing participants to easily link usage experience and motivation into different interview themes. For Article VII, the interview themes used were background information and critical incidents.

While performing the analysis, the answers of the individual participants were compiled into an Excel spreadsheet, which made it easier to compare the

data and see the occurring themes. The most highlighted issues and topics were reported in the results section of each article.

4 RESULTS

This chapter presents the main results of the thesis and the individual articles included in it. The chapter also provides information on the research question that each article provides answers to. Articles I and II focus on physically active people and their experiences using a digital coach while preparing for a ski marathon race. Articles III and IV concentrate on young adults with low levels of physical activity and their experiences with a digital coach. In Articles V and VI, the focus is on young elderly people and their experiences with digital coaching. Article VII examines through critical incidents the main reasons for using or not using a digital coach and focuses on both young elderly people and people with low levels of physical activity.

4.1 Article I: Digital Coaching and Athlete's Self-Efficacy – A Quantitative Study on Sport and Wellness Technology

This article answered to the following research question:

RQ1 How can digital coaching influence exercise self-efficacy?

The article focused on physically active people—more precisely, on cross-country skiers. The goal was to study if and how using a digital coach influenced cross-country skiers' self-efficacy as they prepared for a ski marathon race. The study used quantitative statistical analysis of data received from 40 ski marathon participants. It presented results in three different parts, the first focusing on self-efficacy regarding overall skiing ability, the second on self-efficacy in terms of upcoming race performance, and the third on attitude towards digital coaching.

Based on the results, it can be interpreted that using a digital coach positively influenced skiers' self-efficacy regarding both their skiing technique and their ability to analyse and improve their technique. Using a digital coach seemed to make users more aware of how they could improve their skiing technique and more confident about their technique in general. These

quantitative results were also supported by qualitative questionnaire results in which participants expressed their opinion on the possible changes that had occurred to their skiing during the study period. Of the digital coach users, 65% reported experiencing improvement in their skiing technique and 70% experienced improvement in their knowledge about it. The corresponding values in the control group were 20% and 33%. Almost all participants reported positive changes in their fitness, and no differences were found between digital coach users and control group participants.

In the section regarding self-efficacy ahead of the ski marathon, the results suggested that using a digital coach when preparing for a race had a positive influence on the skiers' self-efficacy in terms of their physical fitness. Digital coach users' trust in their own fitness to have a good race had increased or stayed the same, whereas skiers without a digital coach seemed to show a decrease in their confidence. During the intervention, skiers without a digital coach also seemed to have lost some of their confidence in their skiing technique and how it would affect their upcoming race. All skiers reported having lower self-efficacy in general in terms of their upcoming race just before the ski marathon. However, skiers who did not use a digital coach seemed to be even more afraid of not reaching their goal and had lower confidence in their abilities not faltering during the race.

The third section focused on the change in attitude towards digital coaching and participants' opinion on using a digital coach during an entire skiing season. In general, the attitude towards digital coaching seemed relatively high among all participants at the beginning and the end of the study period. However, skiers who were preparing for the race with a digital coach experienced a slight decrease in their attitude. In other words, using a digital coach for the entire season felt less sensible for them after having had the five-week experience with a digital coach.

4.2 Article II: Can Digital Coaching Boost Your Performance? – Qualitative Study among Physically Active People

This article answered to the following research questions:

- RQ2 How can digital coaching influence exercise motivation?
- RQ3 What experiences do people have when using a digital coaching to support exercising?
- RQ4 What are the ideal characteristics of a sport and wellness technology digital coach?

As in Article I, this article focused on cross-country skiers. The aim was to understand, from an exercise psychological point of view, how using a digital coach influenced physically active people as they prepared for a race. The goal was also to understand how physically active people experienced using their

digital coach as a personal trainer and ascertain their suggestions for digital coaching in general.

Based on the results, a digital coach has the potential to positively influence the exercise motivation of physically active people. The most important factors positively affecting motivation were the ability to monitor one's own performance, receive feedback and observe one's overall development over time. Other motivational factors listed were the ability to receive training advice and suggestions and having the feeling that someone was watching and monitoring training and providing encouragement. These positive effects could be seen to increase the feelings of autonomy, competence and relatedness.

The results also revealed some demotivating factors. Some participants felt having a digital coach that constantly observed them and gave reminders caused stress. Another thing that decreased motivation was the technical issues that participants experienced with the digital coach, which distracted them from their training. Some participants also felt that using a digital coach could make them too performance-orientated and focus too much on performance improvement. These demotivating factors decreased the feeling of competence.

The results also showed that using a digital coach for race preparation caused most participants to experience changes to their normal preparation routines. Such changes included performing more interval training, specific technique training or physically intensive training. Having a digital coach also seemed to make some participants pay more attention to their technique, which made them more focused during a training session, while for some participants, it gave them more confidence for the race ahead due to the perceived development of their skiing technique. Whereas ready-made exercises and encouragement boosted motivation during race preparation, technical usability issues decreased motivation.

Less than half of the participants reported experiencing an increase in their self-efficacy towards the race. The self-efficacy boost was related to the perceived improvement of or reassurance about their skiing technique. According to the participants, the digital coach would have benefited them even more if the usage experience had been longer than five weeks. From the perspective of proxy agent theory, physically active people appreciate that digital coach can bring them extra information and feedback that they would not otherwise receive, or at least not as accurately. This information helps them to further improve their performance.

In general, it seems that physically active people were interested in receiving feedback and different types of data on their performance. However, only half of the participants were interested in following the digital coach's ready-made training plan. The reason for this is that participants wanted to stick to their own routines that felt more suitable to them, or that they felt the digital coach was not able to adapt the training schedule to their overall daily schedule. Real-time feedback seemed to receive more interest than the adaptive training guidance, and it was perceived as useful and interesting. Despite this, participants wished the quality of the feedback were more versatile and personal.

The biggest negative feedback element was related to technical issues and usability, since it was sometimes hard for participants to use the device and their phone in cold weather during training sessions.

The ideal digital coach for physically active people seemed to be a heart rate–detecting device combined with a watch, since most participants disliked having to take their phone with them during training. High quality and accuracy were important qualities for feedback. Whereas more detailed numeric and graphical data were appreciated in general, during the training, audio feedback was considered the most convenient. Besides training data, physically active people seem to be interested in accessing recovery-related information through their digital coach. These data could include feedback related, for example, to nutrition, hydration and rest. When asked, just over half of the participants said they would choose a digital coach over a human coach, whereas the rest would choose either a human coach or both a digital and a human coach together. Among the perceived benefits of the digital coach was how it provided constant feedback and more accurate and science-based knowledge, thereby revealing more reliable and objective information. However, human coaches were appreciated, since they are able to provide a more holistic view of the person. Being able to make changes to training programmes, providing more individual and instructional feedback and being able to take into account other circumstances outside training were each highly appreciated.

4.3 Article III: Digital Coaching among University Students with Low Levels of Physical Activity: A Quantitative Intervention Study on Exercise Self-efficacy

This article answered to the following research question:

RQ1 How can digital coaching influence exercise self-efficacy?

The article focused on university students with low levels of physical activity. The goal was to study if and how using a digital coach can influence self-efficacy related to physical activity and exercising among people with low levels of physical activity. The study used a quantitative statistical analysis of data from 59 university students. The study presented results in three different sections, the first focusing on exercise self-efficacy, the second on self-efficacy related to improving fitness and beliefs about using sport and exercise technology, and the third on attitudes towards digital coaching.

The results showed that using a digital coach could potentially influence the self-efficacy of people with low levels of physical activity. During the 10-week intervention, students in the intervention group experienced increased self-efficacy towards exercising, whereas students in the control group did not. The increase in self-efficacy was shown in increased confidence in overcoming barriers related to feeling tired, feeling depressed, continuing exercising after a break or exercising without the support of other people. The results also showed

that changes in self-efficacy did not take place within the first five weeks of the study; these changes were identified only after comparing the results taken during the entire 10-week intervention period.

Based on the results regarding improved fitness, it can be seen that using a digital coach can increase the level of self-efficacy in terms of analysing one's own fitness and understanding how to improve it. A digital coach can also increase self-efficacy related to creating an exercise programme for oneself and being able to train independently without guidance or coaching. The changes in self-efficacy related to improving fitness took place mostly over the first 5-week period of the 10-week intervention. As a result of using a digital coach, people's beliefs in the reliability, accuracy, and perceived truthfulness of sport and exercise technology decreased. It can be seen that the students in the intervention group experienced decreased trust towards the data they received from their digital coach. Regardless of the decrease, participants' opinions generally remained relatively positive. The changes in beliefs had also already taken place in the first half of the intervention.

The results also showed that using a digital coach had a small negative effect on participants' attitudes towards digital coaching. For digital coach users, the thought of using a digital coach to support one's training sounded less sensible, useful and comfortable than it had before. These changes in attitude did not take place in the first half of the study, but they were identified only after measuring results between the beginning and the end of the intervention. The attitude remained still relatively positive.

4.4 Article IV: Using Digital Coaching to Promote Physical Activity to University Students with Low Levels of Physical Activity: A Qualitative Intervention Study

This article answered to the following research questions:

- RQ2 How can digital coaching influence exercise motivation?
- RQ3 What experiences do people have when using a digital coaching to support exercising?
- RQ4 What are the ideal characteristics of a sport and wellness technology digital coach?

The article investigated digital coaching among people with low levels of physical activity. The aim was to study how using a digital coach influenced their exercise motivation from a psychological point of view. Equally important was to understand how people with low levels of physical activity experience used a digital coach while pursuing a more physically active lifestyle and what suggestions or wishes they had for digital coaching in general. The study was a qualitative study, and the data were collected via interviews.

Most of the participants reported experiencing a small increase in their exercise motivation. The biggest reason for this boost was the ability to receive

data and feedback on their performance. By receiving data participants seemed to be made more aware of their fitness and physical activity, and this increased knowledge led to an increase in motivation. Some participants reported experiencing an increase in their exercise self-efficacy, mostly due to the increased knowledge and positive feedback. Participants also appreciated support from the digital coach and found it helpful that training programmes were planned for them. Having a relatively easy start to their personalised training programmes also increased confidence for some participants. However, some perceived the created training plans as too easy, which led to doubts towards the reliability of the digital coach in general. In all, using a digital coach appeared to increase the level of competence and relatedness among people with low levels of physical activity.

Together with increased exercise motivation, most participants also reported a small increase in physical activity level. Despite the perceived positive effect on motivation and physical activity, participants felt that a digital coach should not be the only source of motivation but was only a useful tool to guide them in right direction. A few participants felt that it could be demotivating if technology demanded too much attention while they were exercising, since this could cause stress. Based on the results, another demotivating factor was the lack of personalisation, since participants felt the digital coach needed to acknowledge and respond to their needs and set goals appropriately.

In general, participants felt that the digital coach was easy to learn and to use. The most frequently used features of the digital coach were adaptive training guidance, real-time feedback, the step counter and the training diary. Sleep, stress and heart rate measurement features were also appreciated. Besides versatile data, participants appreciated receiving notifications. Even though participants liked communicating with the digital coach and receiving data, the biggest negative feedback element was related to the lack of personalisation and the accuracy of the data, namely that even more explanatory, versatile and accurate data were needed.

Some participants wanted a more personalised programme and feedback, especially in relation to adaptive training guidance. A chance to adapt the training programme based on users' other schedules would have also been preferred. In general, the training programme provided by the digital coach was seen as relatively easy. Some found that to be positive, but for others, it was a reason to not trust the information provided and not to follow the training programme. The real-time feedback feature was seen as positive, since it helped participants to train at a suitable intensity level and added variety by changing the intensity level during training.

An ideal coach for people with low levels of physical activity would typically be a mobile solution, a watch or a combination of the two. Some participants would also have appreciated a chest heart rate belt to receive better heart rate data. A few wished that their digital coach was less visible, perhaps a piece of jewellery. The ideal digital coach would provide basic training features such as training plan, intensity and heart rate, and sleep tracking, recovery, step

counting and calorie counting were also considered important. Less common suggestions included features related to nutrition, gym training, measuring body temperature, water consumption, psychological well-being and weather forecasts. Participants said that their ideal digital coach should be adjustable based on their personal needs so that it would include important features or exclude unnecessary ones. The ideal digital coach should also have some human elements, so that it could create a feeling that someone actually cared and was interested.

At the end of the study, most participants said they would prefer a human coach over a digital coach in the future. The reasons for this were related to better two-way interaction, the ability to make more personalised plans and adjustments and the feeling of being accountable to someone. Reasons for choosing a digital coach were related to its lower cost, greater convenience, feeling of freedom and feeling less pressure. Most participants would prefer having both a digital and a human coach together. Even though digital coach as a proxy agent was not as appreciated as a human coach among people with low levels of physical activity, using a digital coach did not lower self-regulatory skills but instead encouraged some participants to take more responsibility over their exercise planning.

4.5 Article V: Young Elderly and Digital Coaching: A Quantitative Intervention Study on Exercise Self-Efficacy

This article answered to the following research question:

RQ1 How can digital coaching influence exercise self-efficacy?

The goal of this article was to study young elderly people and if and how using a digital coach influenced self-efficacy related to physical activity and exercising. The study included 62 young elderly people and was conducted using a quantitative statistical analysis method. The study presented results in three different sections, the first focusing on exercise self-efficacy, the second on self-efficacy related to improving fitness and beliefs about using sport and exercise technology, and the third on attitudes towards digital coaching.

The results showed that using a digital coach did not influence young elderly peoples' exercise self-efficacy. On the exercise self-efficacy scale, only one statement showed a significant difference; this was that young elderly people in the intervention group had higher self-efficacy in being able to motivate themselves to exercise again after having stopped.

When looking at the results in terms of improved fitness, young elderly participants in the intervention group seemed more confident by the end of the study that they could train independently without coaching or guidance. All study participants felt more confident by the end of the study that they did not need help in creating a suitable exercising programme for themselves. However, those in the intervention group were already more confident by the middle of the

study about not needing help. After 5 weeks, intervention group participants also felt more confident in their ability to identify how to improve their fitness. Significant results were found related to opinions and beliefs about sport and wellness technology. Young elderly people in the intervention group had already experienced by the middle of the 10-week intervention a decline in their trust towards sport and wellness technology, especially related to reliability, accuracy and truthfulness.

When looking at the changes in attitudes towards digital coaching, both the intervention and control groups experienced a decline in their attitudes. In general, attitude changes had already taken place in the first half of the intervention period. However, it seems that attitude concerning comfort took place only in the end of the intervention. Regardless of the declines, attitudes towards digital coaching remained generally positive.

4.6 Article VI: Digital Coaching Motivating Young Elderly People towards Physical Activity

This article answered to the following research questions:

- RQ2 How can digital coaching influence exercise motivation?
- RQ3 What experiences do people have when using a digital coaching to support exercising?
- RQ4 What are the ideal characteristics of a sport and wellness technology digital coach?

The article continued the topic of studying digital coaching among the target group of young elderly people. The aim was to understand from an exercise psychology point of view how a digital coach influences young elderly peoples' exercise motivation. The aim was also to explore how young elderly people perceived using a digital coach in their pursuit towards a physically active lifestyle and to ascertain their suggestions and wishes related to digital coaching in general.

Based on the results, digital coaching was perceived by young elderly people to have motivational effects, the biggest of which seemed to be the personalised data regarding users' fitness level, daily physical activity and progress in terms of physical activity and fitness. The positive effects on motivation seemed to take place mostly at the beginning of the study; however, the positive personal progress effects took place at the end of it. Young elderly people felt that a digital coach could provide data that made them more knowledgeable about their own well-being and physical activity and made their exercising more goal-oriented. Therefore, from a psychological point of view, using a digital coach seemed to have increased the feeling of competence. Using a digital coach as a proxy agent boosted young elderly participants to feel more confident in exercising independently.

However, some participants reported receiving a boost in their motivation after seeing from the data that they were in worse shape than they thought. Additionally, using a digital coach seemed to positively influence the feeling of relatedness, since some participants experienced an increase in exercise motivation due to the acknowledgements and positive feedback received from their digital coach. Seven participants reported feeling more confident after the intervention in terms of their physical activity. This increase in self-efficacy was related to the data provided by the digital coach showing an increase in their physical activity levels. Changes in self-efficacy were also reported related to the use of modern technology. Due to the intervention, some participants reported feeling more confident about using modern technology, whereas four reported experiencing a decrease in confidence in this way.

When looking more closely at the usage experience, young elderly people had difficulty learning to use the digital coach and often needed outside help, particularly during initial setup. It seemed that participants aged 60–65 had less trouble using the watch, compared with older participants. The biggest negative issues related to usage experience were in terms of usability, which often made them less confident and less interested in using the digital coach in general. Regardless, many participants seemed to have increased interest towards sport and wellness technology after the intervention. In general, young elderly people seemed to be interested in testing out the different features of their digital coach. However, the most used features were the basic ones, such as step counting, the heart rate monitoring, the distance calculator and sleep monitoring. Adaptive training guidance attracted some participants, but for others, it felt too difficult or inconvenient to use.

Young elderly people seemed to think that the training programmes created by the digital coach were somewhat easy. For many people, this initial realisation increased their belief in their abilities. However, some participants experienced this easiness negatively, since the suggested programmes included less physical activity than they were currently doing. Most participants did not follow the adaptive training guidance closely but still felt that having personalised programmes to follow brought them a boost in motivation. Young elderly people also felt that adaptive training guidance did not consider their established weekly plans, which made following the training plan even harder.

Young elderly people were interested in testing the real-time feedback feature but were not interested in following its instructions. Some participants were annoyed by the constant signalling of the feature, and some just wanted to set the pace for their training themselves. At the end of the intervention, young elderly people seemed to be more interested in having a real-time feedback feature than adaptive training guidance. However, the participants wanted the real-time feedback to be more accurate and personalised.

Most participants did not see any change in their fitness level during the intervention. Instead, they learned new things about their physical activity, sleep and recovery and, as a result, felt more realistic towards their own fitness. Some participants felt more confident. Even though young elderly people seemed to

appreciate the data they received, they wished it was more detailed and explanatory. Some also wanted to have a better understanding of the factors on which the digital coach was basing its personalised suggestions.

When expressing wishes and suggestions for their ideal digital coach, young elderly people preferred having one either in a watch or as a mobile application combined with a heart rate belt. Since it was difficult to read information from a watch, an ideal coach would also provide the ability to read data from a computer. The ideal digital coach would contain basic training features, including sleep and recovery. The participants also suggested that an ideal digital coach could include information related to blood sugar, blood pressure, nutrition, energy consumption and weight training. A digital coach could also issue reminders related to times for eating, sleeping and taking medication.

After the intervention, half of the participants said they would choose a digital coach over a human coach in the future. The reasons for choosing a digital coach were affordability and the feeling of freedom and independence. The other half, who would take a human personal trainer over a digital coach, preferred the human interaction and ability to receive better explanations and feedback and more personalised plans. Almost all participants thought that in an ideal situation, they would have both a human and a digital coach together.

Most participants thought a digital coach was suitable for all kinds of people. However, some thought that it would be more suited to younger people who were either more goal-oriented exercisers or who did not exercise enough. According to young elderly people, having an initial interest in technology would be important when using a digital coach.

4.7 Article VII: Critical Experiences with Sport and Wellness Technology Digital Coach – Differences between Young Adults and Young Elderly

This article answered to the following research questions:

RQ3 What experiences do people have when using a digital coaching to support exercising?

RQ4 What are the ideal characteristics of a sport and wellness technology digital coach?

The article focused on two of the target groups presented earlier, namely young adults with low levels of physical activity and young elderly people. The article included data from 60 participants who had been using a digital coach for 10-week period. The aim of the article was to examine the central critical incidents that novice digital coach users experienced in the implementation phase. The article also set out to study what kind of differences there were between young adults and young elderly participants regarding these critical incidents. Lastly, the article explored how these critical incidents influenced the overall usage

experience and motivation towards physical activity. The study was qualitative and used the critical incident technique of data collection.

Based on the results, critical incidents for younger adults and young elderly people were divided almost equally between positive and negative incidents. For young adults, most of the positive incidents took place during the early stage of the usage experience; that is, at the early phase of the intervention. The positive incidents were often related to becoming more aware of their own fitness level due to the data provided by the digital coach. Other positive incidents were also related to the received data and how participants were able to track their own development and performance. Overcoming one's own expectations was another common positive incident. These positive incidents made participants feel proud of and satisfied with themselves, leading to an increase in motivation for using the digital coach and sometimes to an improved opinion of the digital coach's usefulness.

For young adults, the negative critical incidents were most often related to the functionality of the digital coach. These participants perceived the data to be unreliable and incorrect, and they were therefore left disappointed and frustrated. This decreased their motivation to use the digital coach or, for some participants, led to them giving up on using it entirely. Other negative critical incidents were related to the digital coach being perceived as too complicated or inconvenient to use during training. These negative critical incidents often led to participants giving up using the digital coach or giving up using the real-time feedback.

For young elderly participants, the positive critical incidents were also often related to the data they received from the digital coach. The most common positive incident concerned receiving positive feedback or acknowledgements from the digital coach, which made users feel proud of and pleased with themselves, bringing about a feeling of competence. This increased their motivation to use the digital coach in the future. Other positive critical incidents were related to learning something new about their own fitness and physical activity and receiving proof from the digital coach that their physical activity had improved. These types of critical incidents increased interest in using a digital coach and following its instructions.

The most highlighted negative critical incidents among young elderly participants were related to problems with usability. The participants became frustrated with the technical requirements or felt that the digital coach did not function as expected. These experiences lead to feelings of frustration that decreased interest in using the digital coach. Another negative incident was related to the accuracy of the data, which made participants sceptical about the data and less interested in following the digital coach's instructions. Some negative critical incidents were related to participants perceiving the digital coach to be too difficult or uncomfortable to use.

When looking at the positive critical incidents among both young adults and young elderly, most were related to participants receiving new data about their physical activity or fitness level and feeling positive about their progress

and accomplishments. However, the role of motivational feedback was higher among young elderly participants than it was among young adults.

In both groups, the negative critical incidents were related to the usability and functionality of the digital coach or the perceived accuracy and reliability of the data. However, among young elderly participants, difficulties related to the overall usage of the digital coach were slightly more common, whereas among young adults mistrust of the data was perceived more often as the reason for negative critical incidents. Both positive and negative incidents influenced their motivation to continue using the digital coach in the future with their exercising.

5 DISCUSSION

This chapter combines and discusses the key findings of the thesis. The findings are addressed in terms of both the theoretical and the practical contributions. The chapter ends with a discussion on the limitations of the study as well as suggestions for future research. This discussion chapter also aims to bring new scientific knowledge by assembling the results of the three intervention studies and their articles. The focus is on highlighting if and how the results are different between users with different physical activity background and ages. This viewpoint is further discussed in Section 5.2.3.

From a theoretical perspective, the findings of this thesis provide understanding about the motivational influence of digital coaching. It extends the current theoretical knowledge related to the use of sport and wellness technology by focusing on its new, recently developed digital coaching feature. The practical findings of this thesis provide more insight from an IS perspective, focusing on form factor, usage experience and recommendations. This insight can be utilised by stakeholders such as coaches, personal trainers, sport and wellness technology companies and any other party that is working to promote physical activity. The contribution of the thesis and its relation to previous research is discussed in more detail in the attached articles.

5.1 Research Questions and Summary of the Results

Table 4 lists all the research questions and provides a summary of the results to answer each research question.

TABLE 4 Research questions and answers

Research question	Summary of the results
RQ1: How can digital coaching influence exercise self-efficacy?	For physically active people, using sport and wellness technology digital coaching had a positive effect on self-efficacy related to (skiing) technique. They were more knowledgeable about their technique and how to improve it. This led to lower pre-race anxiety and higher confidence in their technique in consideration of the upcoming race. Using the digital coach also led to increased self-efficacy related to physical fitness in consideration of upcoming race performance. For young adults with low levels of physical activity, using the digital coach influenced exercise self-efficacy related in particular to overcoming exercise barriers such as tiredness, training without support, feeling depressed and continuing exercising after a break. This change took place in the latter part of the intervention. Self-efficacy related to understanding and creating one's own exercise programme was increased, as it was for training independently without guidance. These changes took place in the early phase of the intervention. For young elderly participants, using a digital coach did not seem to influence their exercise self-efficacy greatly. However, self-efficacy related to being able to exercise independently and knowing how to improve one's own fitness increased. These changes took place in the early part of the usage experience. Some young elderly participants experienced increased or decreased self-efficacy related to using modern technology.
RQ2: How can digital coaching influence exercise motivation??	For physically active people, using a digital coach helped increasing the feeling of competence, by monitoring performance and providing data of improvement. The feedback and encouragement from the digital coach were also seen a motivational, thereby increasing the feeling of relatedness. Using a digital coach provided users independence, since the coach was always available. However, negative or unclear feedback could be viewed as demotivating, decreasing the feeling of competence. Focusing too much on the data could also be seen as a possible demotivating factor because it caused too much stress. For young adults with low levels of physical activity, the feeling of competence increased during the digital coach usage experience. This was mostly because of the increased knowledge the digital coach data provided in terms of participants' physical activity. The digital coach's support, feedback and ready-made exercise plans were also seen as motivational, thereby increasing the feeling of relatedness. Lack of personalisation and stress related to receiving too much data were seen as potential demotivating factors. For young elderly people, increased knowledge of personal fitness and how it developed was seen as motivational, thereby increasing the feeling of competence. The digital coach's support, positive messaging and acknowledgements were also seen as motivational and increased the feeling of relatedness. The feeling of autonomy related to exercising was important among young elderly participants.

Research question	Summary of the results
RQ3: What experiences do people have when using digital coaching to support exercising?	Physically active participants perceived the digital coach to be a useful tool for race preparation, as it provided detailed information about their performance, training and progress. Having a digital coach to provide personalised training suggestions and programmes led some participants to step out of their normal training routines. However, some preferred maintaining their own training routines since these was more familiar and easier to adapt to their busy lives. Real-time feedback was seen as very helpful. The functionality and reliability of the digital coach and its data were perceived to be the biggest negative issues. Lack of personalisation in terms of feedback was sometimes perceived as negative. Young adults with low levels of activity perceived the personalised training programmes to be relatively easy. This was seen either as motivating or a reason to doubt the reliability of the digital coach. Participants wished they could adjust the training programmes to better fit their own schedules. The use of real-time feedback was perceived mostly positively and as a means to help participants train at a suitable intensity level as well as to change the intensity of training. Sometimes real-time feedback was seen to be interruptive. Communication with the digital coach was not perceived as clear or effective enough, and more personalisation and explanatory feedback were needed. Using the digital coach and receiving personalised data enabled young adults to become aware of their own physical activity and helped them overcome their beliefs. Perceiving data as too unreliable due to heart rate measurement errors or the digital coach as too complicated to use negatively influenced the usage experience. Young elderly people perceived the personalised training programmes as easy. While some participants viewed this positively, others started questioning the suitability and usefulness of the suggested programmes. Participants wanted to be able to adjust training programmes to fit their weekly plans. For some, the training plans made exercising more goal orientated. Real-time feedback was not considered useful, either because young elderly people wanted to determine their own pace, or it was seen as interruptive and challenging during training. Even though feedback was not always considered personalised enough, the positive messaging and feedback on performance accomplishments were seen motivational. Being frustrated with technology or having mistrust towards the accuracy of the data were negatively influences on the usage experience.
RQ4: What are the ideal characteristics of a sport and wellness technology digital coach?	Physically active participants described their ideal digital coach as a watch combined with a heart rate belt. It should be light and unobtrusive and easy to operate during exercise and preferably provide audio feedback. Outside training sessions, participants would like to read their data from a computer. The ideal digital coach would provide versatile feedback related to training, technique, performance and recovery. Recovery information would include information on hydration, rest and nutrition. Over half of the physically active participants viewed a digital coach as a better option compared with a human coach. The rest would choose either a human coach or a combination of both. A digital coach was preferred because it would always be available, more affordable, more

Research question	Summary of the results
	independent to use and had more science-based knowledge. However, a human coach would be able to take a more holistic view of the person. The ideal digital coach for young adults with low levels of physical activity would be a watch, phone application or even some less visible device together with a heart rate belt. It would provide versatile training-related information and include information related to recovery, sleep, nutrition and gym training. The ideal digital coach would also offer information related to route choices, body temperature measurements, weather forecasts, drinking water consumption, meditation and relaxation. It should provide more personalised information and be adjustable by the customer at the time of purchase. The digital coach should have more human elements and a positive, encouraging and realistic personality. A human coach was still seen to be more attractive than a digital coach, but having both would be the ideal option. The digital coach was appreciated due to its perceived lower cost, freedom, convenience and for causing less stress. A human coach, on the other hand, would see the person as a whole and offer a chance to interaction not only in terms of training. Young elderly people wanted their ideal digital coach to be in the form of a watch or a phone application together with a heart rate belt. They should be able to read information on a computer, not only on a phone or a watch. The ideal digital coach would include basic training data and sleep and recovery data. It could also provide information related to blood pressure, nutrition, blood sugar, energy consumption and tips for muscle training. It could also give notifications related to medication times, eating times and sleep times. A digital coach was seen as an equally good option, compared with a human coach, although a combination of both was perceived as an ideal option. Whereas a digital coach was seen to provide more freedom and independence, and to be more affordable, a human coach was considered a more personalised option that would provide human connection and guidance.

5.2 Theoretical Implications

This thesis studied the use of a digital coach and how it supported different types of users in terms of physical activity from both psychological and practical perspectives of exercise. In this thesis, the theoretical implications relate to the findings in terms of the psychological support and the practical support provided by the digital coach, which are discussed below.

5.2.1 Psychological Support

When considering the results from the perspective of psychological support, the focus was on finding out if and how the use of a digital coach can influence exercise self-efficacy and how it can influence exercise motivation. When looking

at the influence on exercise motivation, the focus was on self-determination theory and how the use of a digital coach could influence needs related to autonomy, competence and relatedness. Proxy agent theory provided a theoretical platform for the use of a digital coach in this study.

From the results, it seems that using a digital coach can influence a user's exercise self-efficacy. Generally, the influence was positive, leading to an increase in self-efficacy. For physically active people, the increase of self-efficacy was more related to performance, technique and improvements, whereas for users with a less physically active background, the positive changes in self-efficacy were more related to physical activity and well-being in general and realisations about one's own abilities and progress. The reason for increased self-efficacy was that the data received from the digital coach led to better knowledge and realisation regarding users' own physical activity, performance or progress. Even though increased knowledge about one's own fitness and physical activity was usually a motivating factor, in a few cases, it was perceived to decrease self-efficacy because the reality did not meet the expectations. However, this mismatch was still more often viewed as bringing extra motivation.

Contradicting the other participant groups in the studies, the group of young elderly participants seemed to have experienced almost no changes in exercise self-efficacy. The only change in this regard was related to their increased feeling of being able to exercise without outside support. Previous research has shown that using sport and wellness technology can have a positive influence on young elderly people's self-efficacy in terms of exercise (Kari et al., 2022). However, the results of Kari et al. (2022) were based on using a simpler technological solution (mobile application) and having a longer intervention period. Therefore, it is interesting to speculate whether the reason for not seeing changes in self-efficacy in this current study were due to the length of the intervention or if the digital coach was perceived as too difficult to use by the young elderly. Even though young elderly participants did not show changes in their exercise self-efficacy, the use of a digital coach did make some of them experience either an increase or decrease in their self-efficacy in terms of using new technology.

It seems that having a digital coach as a proxy agent did not negatively affect users' self-regulatory skills. Based on the findings, using a digital coach did have a positive influence on participants' confidence in terms of feeling knowledgeable about their physical activity, creating their own training plan or training independently without outside support or guidance. These changes took place among younger adults with low levels of physical activity and among young elderly participants. This finding contradicts previous research done among human proxy agents (Shields & Brawley, 2006). It seems that using a digital coach boosted users' confidence in terms of being able to understand and manage their own exercising and physical activity more independently. It seems that for younger adults, these changes took place more in the latter part of the intervention period, whereas the small changes among the young elderly participants took place in the early stage of the intervention. Considering the

theory of proxy agency further, it seems that people want to use digital coaching, since they feel a digital coach can offer them additional information and support that they cannot provide themselves. Some people also appreciated the opportunity for someone else to do the planning.

When looking at the findings related to motivation and the SDT components, using a digital coach could be seen to increase the level of autonomy, and thus influence exercise motivation positively. This may be because participants felt more confident in managing their own physical activity at the end of the intervention period. The young elderly participants seemed to appreciate the feeling of autonomy related to the use of digital coaching; however, the increased level of autonomy also meant that some did not feel the need to continue using the digital coach alongside exercising, since they felt they were able to manage their exercising without extra help. Using a digital coach may have influenced exercise motivation in all the investigated target groups by increasing the feeling of competence by providing exercise data and proof of improvement. This finding supports previous research by Chamorro-Kok et al. (2021) conducted with a more traditional type of sport and wellness technology. However, the feeling of competence can also be decreased if exercising becomes too goal oriented and stressful due to the use of digital coaching. This finding was related to physically active people as well as to those with low levels of physical activity.

Especially among young elderly people, using a digital coach was able to increase the feeling of relatedness. This feeling was the result of receiving positive and encouraging feedback and messaging. The increase in the feeling of relatedness also took place among participants with low levels of physical activity. However, most participants wished that the personalisation and communication aspect of the digital coach was better, since this would further enhance the feeling of relatedness and make the digital coaching even more motivational. This shows that a lack of human elements can also decrease the feeling of relatedness, which does not necessarily appear as a decrease in exercise motivation but as a decrease in using a digital coach as a support for exercising. In addition, mistrust of the accuracy and reliability of the digital coach's data could be a cause of decreased motivation for and confidence in using digital coaching. This finding supports the previous literature (Chamorro-Kok et al., 2021).

Based on the findings, it seems that a digital coach has the potential to provide users with psychological support related to self-efficacy and motivation. However, the type of support depends on users' needs, experience in terms of physical activity and personal preferences.

5.2.2 Practical Support

The practical contribution of this study focuses on digital coaching usage from an IS point of view. The focus here is on the form factor, the usage experience and the perceived ideal digital coach.

For physically active people, it seems important that a digital coach would not physically get in the way of training. Therefore, a watch was considered a better option, compared with a mobile phone solution. Having the digital coach in a phone was sometimes perceived as problematic, especially during ski training, when it was difficult to operate a phone in cold weather. Young adults with low levels of physical activity also preferred digital coaches to be relatively small. Even though a watch was considered a good option in general, some people felt it would be too uncomfortable to wear and would have preferred a smaller and less conspicuous option, such as bracelet or a ring. Many of the participants would prefer a mobile phone solution. For young elderly participants, form factor–related wishes were more related to the screen and buttons. Many participants had problems operating the digital coach, especially in the middle of exercising, due to the small buttons and screen size.

Wrist heart-rate detection was considered a comfortable option in general among the young adult and young elderly participant groups who were testing it. However, since many features of the digital coach were related to heart-rate detection, problems related to heart-rate accuracy influenced the overall usage experience in a negative way. Therefore, participants generally seemed to want an option to wear a heart rate belt. They also seemed to appreciate having the ability to look at training data from a computer and not only from a watch or a phone. Whereas physically active people seemed mostly interested in performance- and recovery-related data, other users were also interested in receiving information and instructions related to health and well-being

The individual training plans created by the digital coach's adaptive training interested some users, especially those who were not experienced exercisers. However, it seemed that users were more inclined to follow or create their own training schedule. Reasons for this were that users found it hard to adapt the digital coach's suggested training plan into their busy schedules. Most perceived the training plans to be relatively easy, which boosted motivation for some users, but this ease caused some to mistrust the accuracy and personalisation of the training plans. However, for some people, having a ready-made training plan brought a new element into their training, and this was perceived positively.

Real-time feedback was generally perceived more positively than adaptive training guidance. However, the technical problems related to heart-rate detection and usability problems related to operating the digital coach during exercise decreased interest in real-time feedback. Users also felt that the communication related to real-time feedback could be enhanced. Despite the problems, real-time feedback seemed to encourage users to step out of their normal training routines and their comfort zone. This was usually perceived as positive.

The biggest benefit of the digital coach seemed to be the data and users' ability to view personal progress. This made users more aware of their own performance and ability and educated them about physical activity and well-being.

Participants seemed to consider digital coaching as an affordable, unbiased and easy option. It also provided users freedom by being always available. However, based on the results, digital coaches should have more human elements, such as increased personalisation and communication. Some users seemed to prefer a human coach over a digital coach because a human coach would see them more as a person and could take into account life outside exercising.

As the findings from previous research highlight, different people have different reasons to exercise. Whereas some people perceive exercise data to be enjoyable and motivating and are interested in performance enhancement, for other people, exercising is more related to spending time alone, enjoying nature, spending time with friends or just finding enjoyment in physical activity itself (Kettunen et al., 2018). Based on this study, digital coaching is more appreciated by people who are more data-orientated, comfortable using technology and enjoy seeing improvement through data.

Based on the results and the experiences found in the three different intervention studies, digital coaching as a concept is perceived as new and interesting. Attitudes towards digital coaching were positive at the beginning of the interventions, although there was a decrease in such attitudes towards digital coaching and its usefulness after using a digital coach. Despite the decline, attitudes remained positive, which reveals that interest in digital coaching still existed among different types of users. The decline in attitudes could also mean that people may have had unrealistic expectations for digital coaching, since the concept was still relatively unfamiliar. This attitude decline, as well as the drop in trust of sport and wellness technology, suggests that digital coaching could and perhaps should be developed further to serve different types of users even better.

The ideal digital coach seemed to mean different things for different users. Whereas physically active people perceived digital coaching mostly as a means of support for exercising, other users were interested in seeing other types of features not necessarily related to exercising in the future. Young elderly users wanted a digital coach that would also support other aspects of their lives, such as providing notifications related to taking medicine and eating times. There were some demands highlighted by all participant groups concerning their ideal sport and wellness technology digital coach. This should be able to take better account of users' personal wishes, backgrounds and life outside exercising. The instructions could also be more personalised, and the communication between the digital coach and the user could be enhanced. These improvements would make the digital coach more pleasant to use and increase its motivational influence.

5.2.3 Comparison between user groups

When looking at both psychological and practical support, the findings support previous literature by Oinas-Kukkonen and Harjumaa (2009) which highlights the importance of primary task, dialogue, system credibility and social support

when designing persuasive information systems. Even though it seems that personal preferences and background influence digital coaching usage and preferences, all user groups appreciated the support received through personalized data and instructions (primary task) as long as they found the information truthful and accurate (credibility). Digital coaching can provide support for users through dialogue and social support but in particular, these elements could be further enhanced to increase the psychological and practical support needed in achieving and maintaining a more physically active lifestyle. Together with the commonalities between the experiences of different user groups, there were also some differences that stood out when comparing the findings. To increase the clarity of the thesis and its findings, these similarities and differences have been highlighted in Table 5.

TABLE 5 Main similarities and differences between user groups

Research question	**Main similarities and differences between user groups**
RQ1: How can digital coaching influence exercise self-efficacy?	Using a digital coach seemed to positively influence self-efficacy of participants in the groups of physically active people and young adults with low levels of physical activity. However, this influence was not seen so clearly among young elderly participants but instead some influence was seen on the self-efficacy related to the use of technology
RQ2: How can digital coaching influence exercise motivation?	For all user groups, using a digital coach increased the feeling of competence related to own performance, knowledge and skills of exercise and physical activity. For young elderly and young adults with low levels of physical activity the usage also promoted the feeling of relatedness. However, young adults also felt that using a digital coach could influence positively their feeling of autonomy.
RQ3: What experiences do people have when using digital coaching to support exercising?	Personalised training program and adaptive training guidance was perceived positively and considered inspiring by some users in all three groups. However, for most people following the digital coach's training program seemed inconvenient. Compared to other groups, real time feedback was seen more positively by physically active people. The young adult participants had more difficulties in using the digital coach compared to other groups. Digital coaching was perceived positively by all user groups but all of them highlighted the need for improved reliability of data and enhanced communication and personalisation.
RQ4: What are the ideal characteristics of a sport and wellness technology digital coach?	Whereas for the physically active people the ideal digital coach seems to be more related to training and performance, for the two other groups the ideal digital coach would include features also related to general wellbeing and other topics. All user groups considered found positive and negative issues when comparing a human coach to a digital coach but the users who seemed to appreciate having a human coach the most were young adults with low levels of physical activity.

5.3 Managerial Implications

This section presents the managerial implications directed towards three different beneficiaries: sport and wellness technology digital coach developers and marketeers; people working in the physical activity promotion, exercise and health sectors; and sport and wellness technology digital coach users.

5.3.1 Implications for Digital Coach Developers and Marketeers

Based on the results, interest in sport and wellness technology digital coaching exists. However, further development should be done to make digital coaches more effective and more suitable for different people's needs. All the users' suggestions for future development were related to the accuracy and reliability of the provided data. Their issues were often related to measuring heart rate. In particular, the wrist heart rate feature was reported to not always provide accurate data. Usability-related problems can often prevent users experiencing the potential motivational benefits by causing them to stop using the digital coach or at least some of its features too early.

Another wish highlighted by all types of users was related to the lack of individualisation. Digital coaches should have more human-like elements to make users feel that the suggestions and feedback is more personalised. Enhancing communication or, for example, creating different personalities for digital coaches could be solutions to make them feel more like a human coach. This finding is aligned with previous research (Boulos & Young, 2021; Mezei et el., 2020). Having instructions and feedback delivered to users in a way that they find motivational could enhance the connection between the digital coach and the user and increase the user's interest in using the device for longer.

All participants agreed that the most interesting, useful and motivational aspect of the digital coach is the data it provides about the users exercising and progress. However, different users appreciated different types of data. Whereas training- and recovery-related data seemed to interest all types of users, data related to nutrition, psychological well-being, health measurement, weather forecasts and different types of notifications seemed to be more desired by those who are not athletes but were more interested in general well-being and physical activity.

Young elderly people found digital coaching interesting, but many of them seemed to have problems related to overall usage. Therefore, digital coaches designed for elderly people should be relatively simple to use and not provide too much information. One option highlighted in results would be to enable users to tailor a digital coach for themselves by allowing them to choose the type of features they wanted or do not want in their digital coach at the time of purchase.

Based on the results, adaptive training programmes could be enhanced in a way that enables users to more easily adapt programmes to their busy lives and schedules. Real-time feedback was considered by many to be interesting and useful. It is, however, important to make the feature easy to use so that it is not

perceived as interruptive, stressful or too difficult to use, so that the user's focus stays on the exercise and not on playing with the technology.

5.3.2 Implications for People Working in Physical Activity Promotion

A digital coach seemed to be a useful tool for teaching people more about their own physical activity and measuring their progress. This knowledge seemed to transfer to increased self-efficacy and motivation, which is important especially for maintaining long-term physical activity or for long-term goals. Therefore, a digital coach can be a suitable tool for physical activity promotion. Since the goal for this is for people to learn to manage their exercising and activities by themselves, a digital coach would seem to be a good option for increasing self-efficacy in terms of managing one's exercising independently.

Compared with a human coach, a digital coach may also feel to be an easier option to start with, as it causes less stress. However, people with lower levels of physical activity seemed to prefer a human coach over a digital one due to human connection and communication. However, people generally felt that in an ideal situation, they would like the chance to use both types of coaches at the same time. As highlighted in previous literature, integrating digital coaching into human coaching may require the human coach to adapt their coaching skills and understanding (Kanatouri, 2020).

Physically active people appreciated the data provided by the digital coach, since it was perceived as more neutral and objective compared, compared with the feedback from a human coach. They appreciated data that could not be seen with a naked eye and therefore felt that the digital coach brought extra value for them.

Young elderly participants had difficulty with usability-related issues, especially when they started to use a digital coach. Providing extra support for usage might be crucial for its continuance.

Based on the findings, it seemed that using a digital coach proxy agent did not make people dependent on outside support in terms of planning and managing their own physical activity. Instead, using a digital coach seemed to increase users' confidence in terms of taking control into their own hands. This finding encourages the practice of including digital coaching with physical activity interventions and programmes.

5.3.3 Implications for Sport and Wellness Technology Users

It is important to remember that the information technology field is developing rapidly, and new devices and solutions are being produced at a rapid pace. This also applies to the sport and wellness technology field. The concept of digital coaching was relatively new at the beginning of this thesis project. However, since then, many more digital coaching solutions and devices have become available on the market. Based on the results, it is not reasonable to say what kind of digital coach would be most suitable for a particular kind of use, as personal differences play a significant role when choosing a right product. The reasons

behind making a choice can be related to previous knowledge of a user's own physical activity, the goals related to exercising, experience in using technology, especially sport and wellness technology, as well as the relationship that a person has with physical activity and exercising in general. It is important to conduct research to find out what kind of digital coach would best suit the needs of an individual user.

For other people, incorporating technology into their training can cause stress and take away the enjoyment of exercising. It is therefore recommended that individuals have an interest in technology before they buy a digital coach.

Based on the results, it is important to realise that even though a digital coach has motivational elements, they alone are not enough if users themselves are not initially motivated to exercise. A digital coach can only add a boost to existing motivation. It is also worth realising that learning to use a new technological device or application for sport takes time, and therefore the motivational benefits do not necessarily appear at the beginning of the usage experience.

5.4 Limitations

This thesis has some limitations. Its results are based on three interventions that used two different digital coaching solutions. It is important to acknowledge that they are from usage experiences with these specific digital coaches and that the results may always be at least slightly different when using another type of digital coach solution. The digital coaches used in the study were designed to be used for sport and well-being. Therefore, the results should not be directly transferred to apply to other fields outside sport and well-being.

The interventions lasted approximately 10 weeks. This length was considered long enough for changes to occur and health-related habits to start developing (Lally et al., 2010) but, at the same time, not too long and demanding from the perspective of the participants. However, changes in lifestyle in terms of physical activity and well-being take a long time, and therefore the results show the influence that digital coaching use had on a relatively short-term basis.

Due to circumstances related to the schedule and delivery of the digital coaching devices, Study 1 was shorter than the subsequent intervention studies. Even though the purpose of the thesis was not to compare the interventions with each other, it is worth remembering that the quantitative results of Study 1 were based on a shorter time frame, compared with those of the other two studies.

The number of participants in the studies was relatively large for a qualitative approach. However, in terms of a quantitative approach, this number was relatively low. Despite this, statistically significant results were found. Nevertheless, due to the low amount of data, the quantitative results should be considered as a means to explain trends rather than hard statistical evidence. The number of participants was limited due to the number of the available digital coaching devices. However, considering the exploratory nature of the study and

the novelty of the topic, the number of participants was considered adequate. Regardless, it is typical in qualitative research that generalisations to larger populations are difficult to make (Myers, 2013). The participants were all recruited in Finland, which also might also lower the level of generalisability of the results.

It is also important to note that the participants who volunteered for the studies did not necessarily represent average people among their population. This limitation is important to acknowledge, especially in the articles on the young elderly population, since these participants were slightly more physically active than average members of their age group. However, it is also important to remember that this type of active people are more likely to use digital coaching devices in general, and therefore their opinion regarding the usage of digital coaching is essential.

The limitations are discussed more in each individual research paper included in the thesis. Despite the limitations, the thesis provides theoretical and practical contribution to the field of IS by providing answers to the research questions. It offers highly valuable insight on the topic of sport and wellness technology digital coaching and its influence especially from a motivational point of view. The findings also serve as a reference for future research.

5.5 Recommendations for Future Research

The findings and limitations of this thesis highlight some potential areas for future research. First, it would be worthwhile to conduct similar intervention studies over a longer time frame to identify more long-term influences. Considering the motivational influences of digital coaching, it would be interesting to focus in future studies on whether the use of digital coaching can change the type of motivation from extrinsic to intrinsic or vice versa. Also, it would be interesting to continue studying digital coaching and its motivational influence by using different types of sport and wellness technology digital coaches or digital coaches meant for other purposes outside sport and wellness.

Since the results of this thesis have shown that digital coaching has the potential to influence users' self-efficacy, it would be interesting in the future to see more detailed studies with larger data sets related to digital coaching and self-efficacy. In general, the topic of digital coaching and its psychological influence still remains an important and interesting topic for research.

Based in previous literature, as well as the results of this thesis, individualisation and personalisation are essential when it comes to digital coaching. Therefore, future studies could focus on how to make digital coaching even more adaptive and personalised and how these changes would then further enhance the usage experiences of digital coaches, as well as their motivational effects. From a usage experience point of view, there are still opportunities for improvement in terms of making it easier for individuals to use digital coaches and also for making users even more engaged with their digital coach. In the

future, it will still be important to research how to make digital coaches more user friendly and interesting and so ensure that their motivational influence will reach users.

Future research could also target different potential user groups who would benefit from physical activity promotion from digital coaching. One potential user group could, for example, be teenagers, since they are generally familiar and comfortable with using technology in many different aspects of their daily lives.

Digital coaching remains a relatively novel research topic. Continuing to conduct research on the influence of digital coaching should be encouraged, especially in the areas of psychology, sport and wellness.

YHTEENVETO (SUMMARY IN FINNISH)

Yhteiskunnassa on kasvava tarve aktivoida kansalaisia kohti terveellisempää ja liikunnallisempaa elämäntapaa. Informaatioteknologia on ollut mukana tukemassa ihmisten terveyskäyttäytymistä mm. liikuntateknologian muodossa. Vaikka liikuntateknologian käyttö ja etenkin teknologian avulla saatu data on osoittautunut hyödylliseksi fyysisen aktiivisuuden tukemisessa, on samalla kasvanut tarve kehittää liikuntateknologiaa etenkin personoidumpaan, ohjeellisempaan ja vuorovaikutuksellisempaan suuntaan ja näin ollen yrittää lisätä liikuntateknologian motivoivaa ja liikuntaa tukevaa vaikutusta.

Digitaalinen valmentaja on yksi uusimmista liikuntateknologisista sovelluksista. Digitaalinen valmentaja ei pelkästään anna palautetta vaan myös ajantasaista ohjeistusta ja ehdotuksia liikuntaan liittyen. Tavallaan se voi siis toimia henkilökohtaisena valmentajana. Liikuntateknologisesta digitaalisesta valmennuksesta ja etenkään sen motivoivasta vaikutuksesta ei toistaiseksi ole paljoa tutkimustietoa. Tämän tutkielman tarkoituksena onkin kartoittaa sitä, miten digitaalisen valmentajan käyttö pystyy tukemaan käyttäjiään liikunnallisen elämäntavan opettelussa ja ylläpidossa. Tutkielmassa tarkastellaan aihetta liikuntapsykologisesta näkökulmasta keskittyen liikuntamotivaatioon ja liikunnalliseen minäpystyvyyteen. Minäpystyvyyden ja motivaation tutkiminen on tärkeää sillä nämä ovat keskeisessä osassa liikuntakäyttäytymisen taustalla ja sen muokkaamisessa. Tutkielmassa tarkastellaan digitaalisen valmentajan käyttöä myös informaatioteknologiselta kannalta keskittyen digitaalisen valmentajan fyysisiin ominaisuuksiin ja käyttäjien kokemuksiin sekä kehitysehdotuksiin. Tällainen teknologian omaksumisen sekä teknologian ja ihmisen välisen vuorovaikutuksen tutkiminen on tärkeää mm. teknologian suunnittelun ja kehittämisen näkökulmasta.

Tutkielma koostuu kolmesta interventiotutkimuksesta, joissa on käytetty sekä laadullisia että määrällisiä menetelmiä. Tutkimukset on toteutettu kolmen eri kohderyhmän keskuudessa: 1. liikunnallisesti aktiiviset ihmiset, 2. nuoret aikuiset, jotka eivät ole liikunnallisesti aktiivisia, sekä 3. nuoret ikäihmiset. Väitöskirjan artikkelit I ja II keskittyvät liikunnallisesti aktiivisiin ihmisiin ja siihen miten digitaalisen valmentajan käyttö vaikuttaa käyttäjien liikunnalliseen minäpystyvyyteen sekä miten se auttaa urheilutapahtumaan valmistautumisessa. Artikkelit III ja IV tarkastelevat liikuntateknologian käyttöä nuorten aikuisten keskuudessa, jotka eivät ole liikunnallisesti aktiivisia. Myös näissä tarkastelun kohteena on digitaalisen valmentajan käytön vaikutus liikunnalliseen minäpystyvyyteen ja motivaatioon liikunnallisen elämäntyylin aloituksen ja ylläpidon aikana. Myös artikkeleissa V ja VI tutkimuksen tarkoitus on sama, mutta nyt kohteena ovat nuoret ikäihmiset – iältään 60-75 v. Artikkeli VII keskittyy digitaalisen valmentajan käyttöön liittyviin kriittisiin tapahtumiin ja siihen miten kyseiset tapahtumat vaikuttavat käytön jatkumiseen. Tässä artikkelissa kohderyhmänä ovat nuoret ikäihmiset sekä nuoret aikuiset, jotka eivät ole fyysisesti aktiivisia.

Tutkimustulokset osoittavat, että digitaalisen valmentajan käytöllä on mahdollista vaikuttaa käyttäjien liikunnalliseen minäpystyvyyteen sekä liikuntamotivaatioon. Digitaalisen valmentajan antama henkilökohtainen palaute ja oman

kehityksen näkeminen lisäävät uskoa omaan tekemiseen ja kasvattavat motivaatiota. Vaikka digitaalisen valmentajan läsnäolo ja tuki koettiin motivoivaksi, tutkimustulosten perusteella motivoivaa vaikutusta voisi lisätä parantamalla digitaalisen valmentajan ja käyttäjän välistä yksilöllistä vuorovaikutusta. Vaikka digitaalinen valmentaja ei välttämättä vielä korvaa ihmisvalmentajaa, voidaan tutkimustulosten perusteella todeta, että digitaalisen valmentajan käyttö kannustaa käyttäjäänsä ottamaan vastuuta omasta liikunnan suunnittelusta ja toteutuksesta.

Väitöskirjan keskeinen teoreettinen kontribuutio on sen luoma arvokas tieto tieteelliselle yhteisölle liittyen käyttäjän ja digivalmentajan väliseen vuorovaikutukseen ja teoreettisen ymmärryksen lisääminen digitaalisten valmentajan käytön liikuntapsykologisista vaikutuksista. Väitöskirja tarjoaa myös useita sen löydöksiin pohjautuvia johtopäätöksiä ja suosituksia eri käytännön toimijoille kuten liikuntateknologian kehittäjille ja markkinoijille, liikunnan ja terveyden parissa työskenteleville henkilöille sekä itse liikuntateknologian käyttäjille. Nämä suositukset edesauttavat digitaalisen valmennuksen kehittämisessä sekä sen hyödyntämisessä terveyttä ja liikunnallisuutta edistäviin tarkoituksiin.

REFERENCES

Adams, S., & Niezen, M. (2016). Digital 'solutions' to unhealthy lifestyle 'problems': the construction of social and personal risks in the development of eCoaches. *Health, Risk & Society*, *17*(7-8), 530-546. https://doi.org/10.1080/13698575.2015.1136409

Allemand, M., & Flückiger, C. (2022). Personality change through digital-coaching interventions. *Current Directions in Psychological Science*, *31*(1), 41-48. https://doi.org/10.1177/09637214211067782

Allemand, M., Keller, L., Gmür, B., Gehriger, V., Oberholzer, T., & Stieger, M. (2020). MindHike, a digital coaching application to promote self-control: rationale, content, and study protocol. *Frontiers in Psychiatry*, *11*, Article 575101. https://doi.org/10.3389/fpsyt.2020.575101

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American psychologist*, *37*(2), 122-147. https://doi.org/10.1037/0003-066X.37.2.122

Bandura, A. (1986). Social Foundations of Thought and Action: A Social Cognitive Theory. Prentice Hall.

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of Human Behavior* (Vol. 4, pp. 71-81). Academic Press.

Bandura, A. (1997). *Self-efficacy: The exercise of Control.* Freeman.

Bandura, A. (2004). Health promotion by social cognitive means. *Health education & behavior, 31*(2), 143-164.

Beauchamp, M. R., Eys, M. A. (2007) *Group Dynamics in Exercise and Sport Psychology – Contemporary Themes.* Routledge.

Beauchamp, M. R., Crawford, K. L., & Jackson, B. (2019). Social cognitive theory and physical activity: Mechanisms of behavior change, critique, and legacy. *Psychology of Sport and Exercise, 42*, 110-117. https://doi.org/10.1016/j.psychsport.2018.11.009

Benítez-Guijarro, A., Ruiz-Zafra, Á., Callejas, Z., Medina-Medina, N., Benghazi, K., & Noguera, M. (2018). General architecture for development of virtual coaches for healthy habits monitoring and encouragement. *Sensors*, *19*(1), Article 108. https://doi.org/10.3390/s19010108

Bitner, M. J., Booms, B. H., & Tetreault, M. S. (1990). The service encounter: diagnosing favorable and unfavorable incidents. *Journal of Marketing*, *54*(1), 71-84. https://doi.org/10.1177/002224299005400l0

Blok, J., Dijkhuis, T., & Dol, A. (2017, March 19-23). *Toward a generic personalized virtual coach for self-management: a proposal for an architecture*. 9th International Conference on eHealth, Telemedicine, and Social Medicine, Nice, France.

Boulos, M. N. K., & Yang, S. P. (2021). Mobile physical activity planning and tracking: a brief overview of current options and desiderata for future solutions. *Mhealth*, *7*. https://doi.org/10.21037%2Fmhealth.2020.01.01

Braun, V. & Clarke, V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006, 3(2), 77–101. http://doi.org/10.1191/1478088706QP063OA

Bray, S. R., & Shields, C. A. (2007). Proxy agency in physical activity. In *Group Dynamics in Exercise and Sport Psychology* (pp. 97-114). Routledge.
Broekhuizen, K., de Gelder, J., Wijsman, C. A., Wijsman, L. W., Westendorp, R. G., Verhagen, E., Slagboom, P.E., de Craen, A.J., van Mechelen, W., van Heemst, D., van der Ouderaa, F., & Mooijaart, S. P. (2016). An internet-based physical activity intervention to improve quality of life of inactive older adults: a randomized controlled trial. *Journal of Medical Internet Research,* 18(4). https://doi.org/10.2196/jmir.4335
Carlsson, C., & Walden, P. (2016). Digital wellness services for young elderly-a missed opportunity for mobile services. *Journal of theoretical and applied electronic commerce research, 11*(3), 20-34. http://dx.doi.org/10.4067/S0718-18762016000300003
Carlsson, C. (2018). Decision analytics mobilized with digital coaching. *Intelligent Systems in Accounting, Finance and Management*, *25*(1), 3-17. https://doi.org/10.1002/isaf.1421
Carron, A. V., Hausenblas, H. A., & Estabrooks, P. A. (2003) *The Psychology of Physical Activity*. McGraw-Hill Companies Inc.
Chamorro-Koc, M., Peake, J., Meek, A., & Manimont, G. (2021). Self-efficacy and trust in consumers' use of health-technologies devices for sports. *Heliyon*, *7*(8), Article e07794. https://doi.org/10.1016/j.heliyon.2021.e07794
Chan, C. B., Ryan, D. A., & Tudor-Locke, C. (2004). Health benefits of a pedometer-based physical activity intervention in sedentary workers. *Preventive Medicine*, *39*(6), 1215-1222. https://doi.org/10.1016/j.ypmed.2004.04.053
Chang, R. C. S., Lu, H. P., Yang, P., & Luarn, P. (2016). Reciprocal reinforcement between wearable activity trackers and social network services in influencing physical activity behaviors. *JMIR mHealth and uHealth*, *4*(3), Article e5637. https://doi.org/10.2196/mhealth.5637
Chatterjee, A., Gerdes, M., Prinz, A., & Martinez, S. (2021). Human coaching methodologies for automatic electronic coaching (eCoaching) as behavioral interventions with information and communication technology: systematic review. *Journal of Medical Internet Research*, *23*(3), Article e23533. https://doi.org/10.2196/23533
Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS quarterly*, 19(2), 189-211. https://doi.org/10.2307/249688
Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319-340. https://doi.org/10.2307/249008
Dennis, A. R., & Valacich, J. S. (2001). Conducting experimental research in information systems. *Communications of the association for information systems, 7*(1), 5. https://doi.org/10.17705/1CAIS.00705
de Vries, H. J., Kooiman, T. J., van Ittersum, M. W., van Brussel, M., & de Groot, M. (2016). Do activity monitors increase physical activity in adults with

overweight or obesity? A systematic review and meta-analysis. *Obesity*, *24*(10), 2078-2091. https://doi.org/10.1002/oby.21619

Deci, E. L., Olafsen, A. H., & Ryan, R. M. (2017). Self-determination theory in work organizations: The state of a science. *Annual Review of Organizational Psychology and Organizational Behavior*, *4*, 19-43. https://doi.org/10.1146/annurev-orgpsych-032516-113108

DePaula, R. (2003). A new era in human computer interaction: the challenges of technology as a social proxy. *Proceedings of the Latin American conference on Human-computer interaction*, 219-222. https://doi.org/10.1145/944519.944543

Duncan, L. R., Hall, C. R., Wilson, P. M., & Jenny, O. (2010). Exercise motivation: a cross-sectional analysis examining its relationships with frequency, intensity, and duration of exercise. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 1-9. https://doi.org/10.1186/1479-5868-7-7

Edvardsson, B., & Roos, I. (2001). Critical incident techniques: Towards a framework for analysing the criticality of critical incidents. *International Journal of Service Industry Management*, *12*(3), 251-268. https://doi.org/10.1108/EUM0000000005520

Edvardsson, B., & Strandvik, T. (2000). Is a critical incident critical for a customer relationship? *Managing Service Quality, 10*(2), 82-91. https://doi.org/10.1108/09604520010318272

Ellen, P. S., Bearden, W. O., & Sharma, S. (1991). Resistance to technological innovations: an examination of the role of self-efficacy and performance satisfaction. *Journal of the Academy of Marketing Science*, *19*(4), 297-307. https://doi.org/10.1007/BF02726504

Faghri, P. D., Omokaro, C., Parker, C., Nichols, E., Gustavesen, S., & Blozie, E. (2008). E-technology and pedometer walking program to increase physical activity at work. *The Journal of Primary Prevention*, *29*(1), 73-91. https://doi.org/10.1007/s10935-007-0121-9

Feltz, D. (1988) Self-confidence and sports performance. *Exercise and Sport Sciences Reviews*, *16*(1), 423-458.

Feltz, D. L., & Lirgg, C. D. (2001). Self-efficacy beliefs of athletes, teams, and coaches. In R. Singer, H. Hausenblas & C. Janelle (Eds.) *Handbook of sport psychology, 2nd edition* (pp.340-361). John Wiley & Sons.

Finnish Sports Federation. (2011) *Kansallinen liikuntatutkimus 2009-2010: Aikuis- ja seniori-liikunta. [National Sports Survey 2009-2010].*

Flanagan, J. C. (1954). The critical incident technique. *Psychological bulletin*, *51*(4), 327-358. https://doi.org/10.1037/h0061470

Gámez Díaz, R., Yu, Q., Ding, Y., Laamarti, F., & El Saddik, A. (2020). Digital twin coaching for physical activities: A survey. *Sensors*, *20*(20), Article 5936. https://doi.org/10.3390/s20205936

Gordon, M., Althoff, T., & Leskovec, J. (2019). Goal-setting and achievement in activity tracking apps: a case study of MyFitnessPal. *The World Wide Web Conference, USA,* 571-582. https://doi.org/10.1145/3308558.3313432

Gremler, D. D. (2004). The critical incident technique in service research. *Journal of Service Research*, *7*(1), 65-89. https://doi.org/10.1177/1094670504266138
Guest, G. MacQueen, K.M. & Namey, E.E. (2012). *Applied Thematic Analysis.* SAGE.
Hagger, M. S., Wood, C. W., Stiff, C., & Chatzisarantis, N. L. (2010). Self-regulation and self-control in exercise: The strength-energy model. *International Review of Sport and Exercise Psychology*, *3*(1), 62-86. https://doi.org/10.1080/17509840903322815
Hameed, M. A., & Arachchilage, N. A. G. (2018). Understanding the influence of Individual's Self-efficacy for Information Systems Security Innovation Adoption: A Systematic Literature Review. *The Proceedings of the 17th Australian Cyber Warfare Conference*, *1809.10890*. https://doi.org/10.48550/arXiv.1809.10890
Helmefalk, M., Marcusson, L., & Sell, A. (2020). Who cares about fireworks? –A Study on Digital Coaching, Gamification and Exercise Motivation. *Proceedings of the 53rd Hawaii International Conference on System Sciences, USA,* 1266-1275. https://doi.org/10.24251/HICSS.2020.156
Hevey, D., Smith, M. L., & McGee, H. M. (1998). Self-efficacy and health behaviour: A review. *The Irish Journal of Psychology*, *19*(2-3), 248-273. https://doi.org/10.1080/03033910.1998.10558189
James, D. (2017). Wearable Technology in sport, a convergence of trends. *Journal of Advanced Sport Technology*, *1*(1), 1-4.
Jowett, S., & Lavallee, D. (2007) *Social Psychology in Sport*. Human Kinetics. https://doi.org/10.5040/9781492595878
Kamel, A., Liu, B., Li, P., & Sheng, B. (2019). An investigation of 3D human pose estimation for learning Tai Chi: A human factor perspective. *International Journal of Human–Computer Interaction*, *35*(4-5), 427-439. https://doi.org/10.1080/10447318.2018.1543081
Kanatouri, S. (2020). Digital coaching: A conceptually distinct form of coaching?. In R. Wegener, S. Ackermann, J. Amstutz, S. Deplazeds, H. Kunzli, & A. Ryter (Eds.), *Coaching im digitalen Wandel* (pp. 40-50). Vandenhoeck & Ruprecht.
Kari, T., & Makkonen, M. (2014). Explaining the usage intentions of exergames. *International Conference on Information Systems 2014 Proceedings*, *New Zealand, 39*.
Kari, T., & Rinne, P. (2018). Influence of Digital Coaching on Physical Activity: Motivation and Behaviour of Physically Inactive Individuals. In A. Pucihar, M. Kljajić, P. Ravesteijn, J. Seitz, & R. Bons (Eds.), *Bled 2018: Proceedings of the 31st Bled eConference. Digital Transformation: Meeting the Challenges* (pp. 127-145). University of Maribor Press. https://doi.org/10.18690/978-961-286-170-4.8
Kari, T., Koivunen, S., Frank, L., Makkonen, M., & Moilanen, P. (2016). Critical Experiences During the Implementation of a Self-tracking Technology. *PACIS 2016: Proceedings of the 20th Pacific Asia Conference on Information Systems*, *Taiwan, 129*.

Kari, T., Koivunen, S., Frank, L., Makkonen, M., & Moilanen, P. (2017). The expected and perceived well-being effects of short-term self-tracking technology use. *International Journal of Networking and Virtual Organisations*, *17*(4), 354-370. https://doi.org/10.1504/IJNVO.2017.088498

Kari, T., Makkonen, M., Frank, L., & Kettunen, E. (2022). Does Physical Activity Application Use Promote Self-Efficacy for Exercise? A Study Among Aged People. *Proceedings of the 55th Hawaii International Conference on System Sciences*, *USA,* 1438-1447. https://doi.org/10.24251/HICSS.2022.179

Kari, T., Salo, M., & Frank, L. (2020). Role of situational context in use continuance after critical exergaming incidents. *Information Systems Journal*, *30*(3), 596-633. https://doi.org/10.1111/isj.12273

Kari, T.; Kettunen, E.; Moilanen, P. & Frank, L. (2017). Wellness Technology Use in Everyday Life: A Diary Study. In A. Pucihar, M. Borstner, C. Kittl, P. Ravesteijn, R. Clarke, & R. Bons (Eds.), *Proceedings of the 30th Bled eConference "Digital Transformation – From Connecting Things to Transforming Our Lives",* (pp. 279-294). University of Maribor Press. https://doi.org/10.18690/978-961-286-043-1.20

Kettunen, E., Kari, T., Moilanen, P., Vehmas, H.-M., & Frank, L. (2017). Ideal Types of Sport and Wellness Technology Users. In A. Harfouche, A. Pateli, A. Polyviou, N. Pouloudi, A. Kokkinaki, & T. Torre (Eds.), *MCIS 2017 : 11th Mediterranean Conference on Information Systems* (Article 19). MCIS.

Kettunen, E., & Kari, T. (2018). Can Sport and Wellness Technology be My Personal Trainer?: Teenagers and Digital Coaching. In A. Pucihar, M. Kljajić, P. Ravesteijn, J. Seitz, & R. Bons (Eds.), *Bled 2018: Proceedings of the 31st Bled eConference. Digital Transformation : Meeting the Challenges,* (pp. 463-476) .Universiy of Maribor Press. https://doi.org/10.18690/978-961-286-170-4.32

Kinnunen, J., & Georgescu, I. (2021). Intuitive Fuzzy Real Options in Digital Coaching for Strategic Investment Decisions. In Dima, A.M., D'Ascenzo, F. (Eds.), *Business Revolution in a Digital Era* (pp. 191-206). Springer.

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International Journal of Information Management*, *45*, 191-210. https://doi.org/10.1016/j.ijinfomgt.2018.10.013

Kroll, T., Kehn, M., Ho, P. S., & Groah, S. (2007). The SCI exercise self-efficacy scale (ESES): development and psychometric properties. *International Journal of Behavioral Nutrition and Physical Activity*, *4*, Article 34. https://doi.org/10.1186/1479-5868-4-34

Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology, 40*(6), 998-1009. https://doi.org/10.1002/ejsp.674

Larsen, R. T., Christensen, J., Juhl, C. B., Andersen, H. B., & Langberg, H. (2019). Physical activity monitors to enhance amount of physical activity in older adults–a systematic review and meta-analysis. *European Review of Aging and Physical Activity*, *16*(1), 1-13. https://doi.org/10.1186/s11556-019-0213-6

Lentferink, A. J., Oldenhuis, H. K., de Groot, M., Polstra, L., Velthuijsen, H., & van Gemert-Pijnen, J. E. (2017). Key components in eHealth interventions combining self-tracking and persuasive eCoaching to promote a healthier lifestyle: a scoping review. *Journal of Medical Internet Research*, *19*(8), e7288. https://doi.org/10.2196/jmir.7288

Levy, Y., & Green, B. D. (2009). An empirical study of computer self-efficacy and the technology acceptance model in the military: A case of a US Navy combat information system. *Journal of Organizational and End User Computing (JOEUC)*, *21*(3), 1-23. https://doi.org/10.4018/joeuc.2009070101

Liebermann, D. G., Katz, L., Hughes, M. D., Bartlett, R. M., McClements, J., & Franks, I. M. (2002). Advances in the application of information technology to sport performance. *Journal of Sports Sciences*, *20*(10), 755-769. https://doi.org/10.1080/026404102320675611

McAuley, E., & Blissmer, B. (2000). Self-efficacy determinants and consequences of physical activity. *Exercise and Sport Sciences Reviews*, *28*(2), 85-88.

McAuley, E., Mullen, S. P., Szabo, A. N., White, S. M., Wójcicki, T. R., Mailey, E. L., Gothe, N.P., Olson, E.A., Voss. M., Erickson, K., Prakash, R., & Kramer, A. F. (2011). Self-regulatory processes and exercise adherence in older adults: executive function and self-efficacy effects. *American Journal of Preventive Medicine, 41*(3), 284-290. https://doi.org/10.1016/j.amepre.2011.04.014

Meuter, M. L., Ostrom, A. L., Roundtree, R. I., & Bitner, M. J. (2000). Self-service technologies: understanding customer satisfaction with technology-based service encounters. *Journal of marketing*, *64*(3), 50-64. https://doi.org/10.1509/jmkg.64.3.50.18024

Mezei, J., Sell, A., & Walden, P. (2020). Digital coaching-an exploratory study on potential motivators. *Proceedings of the 53rd Hawaii International Conference on System Sciences, USA*. https://hdl.handle.net/10125/63879

Miyamoto, S. W., Henderson, S., Young, H. M., Pande, A., & Han, J. J. (2016). Tracking health data is not enough: a qualitative exploration of the role of healthcare partnerships and mHealth technology to promote physical activity and to sustain behavior change. *JMIR mHealth and uHealth*, *4*(1), Article e5. https://doi.org/10.2196/mhealth.4814

Molina, M. D., & Sundar, S. S. (2020). Can Mobile Apps Motivate Fitness Tracking? A Study of Technological Affordances and Workout Behaviors, *Health Communication, 35*(1), 65-74. https://doi.org/10.1080/10410236.2018.1536961

Moritz, S. E., Feltz, D. L., Fahrbach, K. R., & Mack, D. E. (2000). The relation of self-efficacy measures to sport performance: A meta-analytic review. *Research Quarterly for Exercise and Sport*, *71*(3), 280-294. https://doi.org/10.1080/02701367.2000.10608908

Myers, M. D., & Newman, M. (2007). The qualitative interview in IS research: Examining the craft. *Information and Organization*, *17*(1), 2-26. https://doi.org/10.1016/j.infoandorg.2006.11.001

Myers, M. D. (2013). *Qualitative research in business and management (2nd edition)*. Sage.
Myers, M. D., & Avison, D. (Eds.). (2002). *Qualitative research in information systems: a reader*. Sage.
Neupert, S. D., Lachman, M. E., & Whitbourne, S. B. (2009). Exercise self-efficacy and control beliefs: Effects on exercise behavior after an exercise intervention for older adults. *Journal of aging and physical activity, 17*(1), 1-16. https://doi.org/10.1123/japa.17.1.1
Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the association for Information Systems*, 24(1), 28. https://doi.org/10.17705/1CAIS.02428
Oinas-Kukkonen, H. (2013). A foundation for the study of behavior change support systems. *Personal and ubiquitous computing, 17*(6), 1223-1235. https://doi.org/10.1007/s00779-012-0591-5
Olaru, G., Stieger, M., Rüegger, D., Kowatsch, T., Flückiger, C., Roberts, B., & Allemand, M. (2022). *Personality Change Through a Digital-Coaching Intervention: Using Measurement Invariance Testing to Distinguish Between Trait Domain, Facet and Nuance Change*. PsyArXiv. https://doi.org/10.31234/osf.io/pfxbd
Payne, A. F., Storbacka, K., & Frow, P. (2008). Managing the co-creation of value. *Journal of the Academy of Marketing Science*, *36*(1), 83-96. https://doi.org/10.1007/s11747-007-0070-0
Petsani D, Kostantinidis E, & Bamidis P. (2018). Designing an E-coaching System for Older People to Increase Adherence to Exergame-based Physical Activity. *Proceedings of the 4th International Conference on Information and Communication Technologies for Ageing Well and e-Health, Portugal*, 258-263.
Racefox. (2022). *Racefox Ski*. Retrieved June 7, 2022 from https://racefox.com/en/ski
Romeo, A., Edney, S., Plotnikoff, R., Curtis, R., Ryan, J., Sanders, I., Crozier, A., & Maher, C. (2019). Can smartphone apps increase physical activity? Systematic review and meta-analysis. *Journal of Medical Internet Research*, *21*(3), Article e12053. https://doi.org/10.2196/12053
Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, *25*(1), 54-67. https://doi.org/10.1006/ceps.1999.1020
Ryan, R. M., Frederick, C. M, Lepes, D., Rubio, N. & Sheldon, K. M. (1997). Intrinsic Motivation and Exercise Adherence. *International Journal of Sport Psychology*, *28*, 335-354.
Ryan, R. M., Williams, G. C., Patrick, H., & Deci, E. L. (2009). Self-determination theory and physical activity: The dynamics of moti-vation in development and wellness. *Hellenic Journal of Psychology, 6*(2), 107–124.
Salo, M., & Frank, L. (2017). User behaviours after critical mobile application incidents: the relationship with situational context. *Information Systems Journal*, *27*(1), 5-30. https://doi.org/10.1111/isj.12081

Šamija, I., Sporis, G. and K. Šamija (2016). Self-efficacy scale construction n and validation in swimming. *Acta Kinesiologica*, *10*, 33-37.

Sell, A., Walden, P., Carlsson, C., Helmefalk, M., & Marcusson, L. (2019). Digital coaching to support university students' physical activity. In A. Pucihar, M.K. Borstnar, R. Bons, J. Seitz, H. Cripps, & D. Vidmar (Eds.), *32nd Bled eConference Humanizing Technology for a Sustainable Society,* (pp. 599-618). University of Maribor Press. https://doi.org/10.18690/978-961-286-280-0.32

Shields, C. A., & Brawley, L. R. (2006). Preferring proxy-agency: impact on self-efficacy for exercise. *Journal of Health Psychology*, *11*(6), 904-914. https://doi.org/10.1177/1359105306069092

Silacci, A.; Khaled, O.A.; Mugellini, E.; & Caon, M. (2020). Designing an e-Coach to Tailor Training Plans for Road Cyclists. In Ahram, T., Karwowski, W., Pickl, S., Taiar, R., (Eds), *Human Systems Engineering and Design II* (pp. 671–677). Springer International Publishing. https://doi.org/10.1007/978-3-030-27928-8_102

Sundar, S.S., Bellur, S., & Jia, H. (2012). Motivational Technologies: A Theoretical Framework for Designing Preventive Health Applications. In: M. Bang, E.L. Ragnemalm, (Eds.) *Persuasive Technology. Design for Health and Safety. PERSUASIVE 2012. Lecture Notes in Computer Science, vol 7284* (pp. 112-122). Springer. https://doi.org/10.1007/978-3-642-31037-9_10

Suunto. (2022) *Suunto Fitness 3 Black – training watch with activity tracking*. Retreived August 3, 2022 from https://www.suunto.com/en-gb/Products/sports-watches/suunto-3-fitness/suunto-3-fitness-all-black/

Taylor, S., & Todd, P. (1995). Decomposition and crossover effects in the theory of planned behavior: A study of consumer adoption intentions. *International Journal of Research in Marketing, 12*(2), 137-155. https://doi.org/10.1016/0167-8116(94)00019-K

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 1-30. https://doi.org/10.1186/1479-5868-9-78

UKK Institute. (2020). *Weekly Physical Activity Recommendations for 18-64-year-olds.* https://ukkinstituutti.fi/en/products-services/physical-activity-recommendations/weekly-physical-activity-recommendation-for-18-64-year-olds/

Volkova-Volkmar, E., Gordon, S., Matei, A., & Payne, A. (2016). Consumer perceptions of digital health coaching. *Frontiers In Public Health. Conference Abstract: 2nd Behaviour Change Conference: Digital Health and Wellbeing, 14.* https://doi.org/10.3389/conf.FPUBH.2016.01.00014

Wang, J. B., Cataldo, J. K., Ayala, G. X., Natarajan, L., Cadmus-Bertram, L. A., White, M. M., Madanat, H., Nichols, J. F., & Pierce, J. P. (2016). Mobile and Wearable Device Features that Matter in Promoting Physical Activity. *Journal of Mobile Technology in Medicine*, *5*(2), 2–11. https://doi.org/10.7309/jmtm.5.2.2

Wilson, J. (2014). Essentials of business research: A guide to doing your research project. *Essentials of Business Research*. SAGE.

Winstein, C. J., & Schmidt, R. A. (1990). Reduced frequency of knowledge of results enhances motor skill learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*(4), 677-691. https://doi.org/10.1037/0278-7393.16.4.677

WHO (2020). Physical Activity. Fact sheet, World Health Organization (WHO). https://www.who.int/news-room/fact-sheets/detail/physical-activity

Xiao, X., Hedman, J., Tan, F. T. C., Tan, C. W., Lim, E. T., Clemenson, T., Henningsson, S., Mukkamala, R.R., Vatrapu, R., & van Hillegersberg, J. (2017). Sports digitalization: An overview and a research agenda. *ICIS 2017 Proceedings, Republic of Korea, 38,* 1-21.

Yasser, A., Tariq, D., Samy, R., Hassan, M. A., & Atia, A. (2019). Smart coaching: Enhancing weightlifting and preventing injuries. *International Journal of Advanced Computer Science and Applications*, *10*(7), 686-691. https://doi.org/10.14569/IJACSA.2019.0100789

ORIGINAL PAPERS

I

DIGITAL COACHING AND ATHLETE'S SELF-EFFICACY – A QUANTITATIVE STUDY ON SPORT AND WELLNESS TECHNOLOGY

by

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Research full-length paper

Track: Improving Lives with Information Technology

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Abstract

The use and demand for sport and wellness technology devices among athletes are increasing. The technology is used to improve the quality of training but also to improve quality of life by, for example, reducing risk of injury. Together with the increased interest towards sport and wellness technology, the demand for clear and easy to understand personalized information is growing. Digital coaching offers solutions for this demand by not only providing valuable training data but also offering instructions and guidance on how to improve the training. By doing this, the sport and wellness technology can act as a personal coach and therefore can also affect athletes' confidence and perception of their own abilities through, for example, evaluative feedback, expectations and verbal persuasion. This exploratory study investigates subjectively perceived effects of digital coach among cross-country skiers. The focus was on the changes in the level of athletes' self-efficacy during a one-month period when preparing for a ski marathon race. The results indicate that a digital coach can increase the athletes' knowledge regarding their technique as well as provide improvement on perceived level of skiing technique. These results give more insight to sport technology companies as well as athletes and coaches about the effects and possibilities of digital coaching among athletes.

Keywords: Digital Coach, Digital Coaching, Sport Technology, Digital Wellness, Self-efficacy, Athlete.

1 Introduction

Recent development in technology has made a significant impact in the field of sports. The information received from technology, especially from various sport and wellness technology devices, has enabled a new level of training feedback during and after a session that athletes and coaches pe nowadays consider invaluable. Receiving reliable and appropriate feedback is an important factor in improvement of sport skills. The probability of learning increases when an athlete is able to compare the internally expected optimum performance with statistics on actual movement outcome (Liebermann et al., 2002). Therefore, the effect of information technology on sport performance seems to be positive as athletes develop more effectively towards their optimum performance.

According to Winstein and Schmidt (1990), feedback sources are more relevant and considered more effective during the beginning of a skill acquisition process and their importance decreases when the skill level increases. Therefore, in general, sport and wellness technology devices providing immediate feedback have been considered to be relevant for recreational, amateur or professional athletes at the initial state of skill acquisition (Liebermann et al., 2002). However, it is important to acknowledge that different athletes have different specific needs regarding feedback sources. According to Halson et al. (2016) sport technology companies should consider the implications for the athletes more since, for example, giving too much information, unnecessary information or inadequate information might cause the user stress and anxiety.

While sport and wellness technology is developing and the devices become less expensive, more athletes have integrated technology into their training. It has been shown to not only improve the quality of their training, but also reduce their risk of injury. Sport and wellness technology can provide the athlete daily feedback, but without professional help interpreting the feedback, it may lead to inappropriate adjustments in training (Duking et al., 2016). Therefore, sport technology companies should not only pay attention to the quality and versatility of the information provided but also the level at which the feedback is easily understood and implemented correctly into practice.

Despite the recent trend on sports regarding digitalization, the topic still remains an understudied topic in the IS discipline (Xiao et al., 2017). When looking at sport and wellness technology more generally, there are a few studies that have focused on the use and effects of technology on physical activity. According to previous studies, sport and wellness technology can increase the level of awareness of personal physical activity and by doing so, increase motivation. (e.g., Chan et al., 2004; Faghri et al., 2008; Kang et al., 2009; Kari et al., 2017a; Wang et al., 2016). Despite the fact that tracking physical activity data may lead to increased awareness, this effect might not be sufficient to maintain the use of sport and wellness technology (Miyamoto et al., 2016). Furthermore, this can have an effect on maintaining physical activity routines (Warraich, 2016). Therefore, it is likely that providing achievable goals and sufficient usage guidance would increase the adherence of using sport and wellness technology devices. These goals and guidance can help users to create and maintain overall wellness routines for example related to physical activity, nutrition and sleep and recovery.

Based on previous research, users prefer their sport and wellness technology devices to deliver clear, relevant and easy-to-understand information. They also feel they need to receive feedback and instructions on how to maintain or enhance their physical activity and overall wellness. When users receive this type of data, it would likely lead to the use being more goal-oriented (e.g., Kari et al. 2016; Kari et al. 2017b), which can contribute to increased motivation (Locke and Latham, 2002; Shilts, Horowitz, and Townsend, 2004). However, a common problem with sports and wellness technology devices is that instead of providing actual guidance and instructions they mostly provide feedback through numbers and graphs. By providing more instructional and personalised feedback via, for example, personal training plans, these devices not only could make their users more motivated and goal-oriented towards improving their physical activity and overall wellness, but also motivate them to continue using the devices.

One prospective solution to serve this demand is digital coaching. The demand for digital coaching to address personalized and goal-driven support in achievements of physical activity goals was also recognized by Schmidt et al. (2015). Digital coaching refers to a service on a technological device that mirrors that of a real coach, by giving feedback as well as advice and suggestions for a user to follow in the pursuit of their wellness and fitness goals. According to Schmidt et al. (2015) a digital coach can identify the strengths and weaknesses of a user and generate a training plan based on the information received from the user. Whereas traditional sport and wellness technology products improve the user's awareness based on their own fitness data, a digital coach is a one step ahead. It can also create a personalized training plan for the user to follow. The use of a digital coach in a physical activity setting as well as its potential in increasing motivation was also highlighted by Kranz et al. (2013) and Kettunen & Kari (2018).

The interest towards digital coaching solutions has been increasing among different stakeholders. However, since commercial digital coaching solutions are still relatively new, there are only a limited number of studies that focus on the influence of digital coaching on usage experiences. To address this research gap, the purpose of this study is to explore usage experience from a psychological point of view by examining the effect a digital coach can have on athlete's self-efficacy. More precisely, the purpose of this study is to investigate the relationship of digital coaching from a sport psychological point of view by focusing on the following question: Can the use of a digital coach affect cross-country skiers' awareness and self-efficacy when preparing for a ski marathon race. The concept of self-efficacy was chosen for the study as a significant relationship between sport performance affecting the choice of activity, effort expenditure, persistence level and vulnerability to stress and depression has been shown (Bandura, 1997). The study included 38 cross-country skiers taking part in the same ski marathon race, skiing either 30km or 50km. The study participants were divided into intervention and control groups. During the one-month study period the intervention group participants were using a digital coach as their personal trainer. Online self-assessment surveys were sent to all participants at both before the beginning and the end of the study period. The survey measured the participants' self-efficacy and awareness of their technique and fitness. The findings of the study provide interesting first insights on the use of digital coaching solutions. Moreover, this research aims to serve as a catalyst to future research regarding digital coaching in the setting of sports and physical activity as well as sports psychology.

2 Theoretical background

The theoretical background of the study comes from the theory of self-efficacy described by Alfred Bandura (1977). Self-efficacy refers to a person's beliefs in their capabilities of performing a specific task. It is not concerned about the skills an individual possesses but rather about the judgements of an individual regarding what they can do with their skills. People with high levels of self-efficacy are more likely to perceive difficult tasks as challenges to overcome and perform better, whereas people with lower levels of self-efficacy might avoid doing tasks they perceive difficult. The level of self-efficacy can also affect motivation since it affects how much effort a person is willing to expend and how long they will persist in the face of aversive experiences and obstacles. Moderately challenging tasks may produce satisfaction through the experience of achievement. On the other hand, motivation can decrease if the tasks are deemed to be too easy or too difficult compared to the perceived own skills and abilities (Bandura, 1998).

According to Bandura, there are four different sources of information that affect the person's self-efficacy: performance accomplishments, vicarious experience, verbal persuasion and physiological states. Performance accomplishments are based on mastery experiences and are the most influential source of self-efficacy. Vicarious experiences refer to experiences received through observing other people. Verbal persuasion means comments and feedback heard from other people, and lastly, the physiological state means the perceived emotional arousal, such as stress, experienced in a particular situation. The construct of self-efficacy is part of Bandura's social cognitive theory (1986) which em-

phasizes that the actions, reactions and social behaviour of an individual are influenced by actions of others they have observed. The social cognitive theory highlights the role of social experience and observational learning in personality development and has often been used as a framework theory for studies focusing on physical activity and motivation. The theory of self-efficacy has been the most widely used theory when studying self-confidence in sports performance (Feltz, 1988).

In this study the focus of the theoretical background is to apply to a physical activity and sports setting. Therefore, the theory of self-efficacy is being studied from the point of view of an athlete's self-efficacy regarding their overall skills as well as their self-efficacy related to the upcoming competition and performance situation. The concept of self-efficacy was chosen for the study since it has an important impact on sport performance and is a reliable predictor of sport performance (Moritz et al., 2000). High self-efficacy has also been shown to accompany low pre-competition anxiety, strong goal importance, high personal goals and high trait sport confidence (Feltz and Lirgg, 2001). Athletes with a high level of self-efficacy will also participate more frequently, put more effort and also persist longer, enhancing their performance in sports (Bandura, 1986). Therefore, self-efficacy plays an important role in athletes' everyday life.

Another term this study derives from Bandura's social cognitive theory is the term of proxy agency. It is based on the idea that people play an active and essential role in their self-development, self-renewal and adaption by using mechanisms called agents. Bandura explains the term agency as acts that are done on purpose and describes three different types of agencies: personal, collective and proxy. In the case of personal agency, the persons themselves act as an agent, whereas in the case of collective agency, the agent refers to a group or a community. In the case of proxy agency, a third-party acts as an agent on a person's behalf (Bandura, 1982; Beauchamp and Eys, 2007).

When looking at the theory of proxy agency from a sport and physical activity point of view, a person can act as their own personal agent when coaching themselves. In the case of a collective agency, a sports club or a team can act as an agent, and in the case of a proxy agency, the agent can, for example, be a coach or a personal trainer who is responsible for planning and executing the training plan and evaluating the progress of performance. According to Bandura, there are three reasons for people to use a proxy agent. The first reason explains that people might feel they do not have the skills or knowledge to reach their desired outcome. Secondly, even though people might feel they do have skills and knowledge, they might perceive that a proxy agent is able to better facilitate their journey to the desired outcome. The third reason refers to a situation where people have all the needed resources but they prefer to have a proxy agent because they want to give up the control and responsibility to someone else (Bandura, 1997).

In a sport setting the use of a proxy agent can be helpful in managing tasks and environmental demands as well as controlling and regulating exercise behaviour. It can also help in lifestyle management and giving instructions and support when developing new skills (Beauchamp and Eys, 2007). A proxy agent can also provide social support, which may increase the likelihood of focus, full involvement and enjoyment, and increase the positive outcomes (Jowett and Lavallee, 2007). In sport settings the role of a proxy agent is often performed by a coach or a trainer who is often able to affect the athlete's self-efficacy in different ways such as by providing vicarious experiences and using persuasive techniques. Persuasive techniques are widely used by coaches, trainers, parents, team managers, etc. to influence athlete self-efficacy. These techniques include, for example, verbal persuasion, expectations, evaluative feedback and imagery. The extent of the influence of using persuasive techniques seems to be dependent on the credibility, expertise, prestige and trustworthiness of the persuader. However, the effect of verbal persuasion to the level of athlete self-efficacy is likely to be weaker than the effect of an athlete's own performance accomplishments (Feltz and Lirgg, 2001).

In this study, the role of proxy agency theory is examined from a digital coach point of view. Therefore, the proxy agent in this study refers to a sport and wellness technology device or application combined with digital coaching features. It has been suggested that a long-term use of a proxy agent might lower the user's self-regulatory skills that are necessary for the independent management of physical

activity and sport participation (Shields and Brawley, 2006). Compared to using a personal trainer or a coach as a proxy agent, using a digital coach as a proxy agent requires the user to have a certain amount of independence and self-regulatory skills. Therefore, using a digital coach encourages the user to practice independence while still in the proxy context.

3 Methodology

3.1 The digital coach used in this study

The digital coach used in this study is called Racefox Ski (Racefox, 2018). The reason for selecting this particular product is that it was, according to our knowledge, the only digital coach product developed specifically for cross-country skiing. Racefox is a sport technology device that comprises a chest strap sensor (similar to a typical ECG heart rate strap) mounted with a pod containing an accelerometer, and a companion app. The chest strap is worn while cross-country skiing and measures various key performance indices (KPI) based on the movement of the user, represented by the movement of the user's torso. The maximum values of the KPI's are based on the technique analysis international level cross-country skiers. The data is collected with the chest strap, which may also include heart rate information, and is transmitted via Bluetooth to a user's smart phone. The smart phone's GPS data is also collected to contribute to the analysis (Racefox, 2018).

The app provides three key services for the user. The first is the creation of user-specific training programs. The user can perform a technique test, which provides baseline performance data. The app uses this data to create a two-week training program. After two weeks, the user is instructed to perform the test again, and the next two weeks are generated based on the new results. The user may also specify a specific goal race and result, which the app will factor in when creating the program. The training program provides specific interval training sessions, which include the number and duration of the intervals and values of the KPIs the user should aim to achieve.

Second is the analysis and feedback from exercise sessions. The app measures multiple KPIs specific to the "traditional" style of cross-country skiing. After each session, the user is provided with a graphical and numerical representation of their performance in each of the KPIs. A "coach" function provides text feedback on the user's technique and specific feedback on how to improve. The feedback also includes links to blog posts and videos on skiing technique. An example feedback phrase may be "You are sitting too much. Try to ski with higher hip and more pressure on your forefoot".

The third service is real-time analysis and feedback. Using headphones or the user's smart phone speakers, the app can provide audio feedback on the user's technique. During a guided interval session, there are specific values of one of the KPIs the user is instructed to achieve for a certain period of time. They will also be instructed as to when to start the interval (for example, "Interval 1 begin, 3 minutes"), and when to stop ("Rest for 3 minutes").

During each interval, the app provides real-time feedback on the user's performance related to the KPI values they are attempting to achieve. For example, a user may be instructed to perform 6 repetitions of 3 minutes of double-poling, maintaining an "Attack" score of 11.4. After each double-pole stroke, the user will hear either a high pitched, "positive" tone denoting that they achieved the goal value, or a lower "negative" tone if they did not. This continues during the entire the interval workout. A different type of interval workout may provide metronome-style tones that guide the user to a specific frequency of double-poling to achieve during the interval. After the session, the user is notified as to they achieved the goal performance of the workout and provided recommendations for future workouts. A user may also create their own custom interval session and customize the type of feedback they want. Or, they may perform a basic distance workout and receive intermittent feedback based on the time or distance skied. In addition to cross-country skiing, the Racefox system may also be used while roller-skiing or doing stationary double-poling sessions, and the company also uses the same equipment with a companion Racefox Run app, which performs similar functions for runners.

3.2 Data collection and analysis

The study was conducted as an intervention study with an intervention group and a control group. The target population of the study were cross-country skiers (henceforth referred to as skiers) who took part in a long-distance ski race in Finland on March 2018. The two optional race distances were 50 km or 30 km, which could be skied in either classic or skate style. The participants of the study were recruited in co-operation with a local ski club that organised the race. An invitation to participate in the study was sent by the club to approximately 900 people via e-mail. This included both people who had already registered for the race and all the club members. The invitation yielded interest from 40 volunteers who were all recruited for the study. Of them, all who were doing the race in classic style and were interested in using a digital coach when training for the race were allocated to the intervention group. In contrast, those who were doing the race in skate style or who were not interested in using a digital coach when training for the race were allocated to the control group. The skiing style was used as an allocation criterion due to the fact that the Racefox Ski digital coach was not yet able to analyse the skiing done in skate style, only in classic style.

The duration of the study was approximately five weeks. At the beginning of the study, the participants in both the groups were measured for the first time by using an online survey. After this, the participants in the intervention group were each given their personal Racefox Ski digital coach, which they were asked to use in the most suitable way for them when training for the race. In contrast, the participants in the control group continued training for the race in their normal way. A few days before the race, the participants in both the groups were measured for the second time by using another online survey. Here, it is important to note that since this measurement was done before the race, its results were not affected by the race itself.

In the two online surveys, the measurements were conducted identically for both the groups. The survey questionnaire contained 30 items measuring the self-efficacy regarding overall skiing ability and upcoming race performance by using a seven-point Likert scale ranging from 1 = "strongly disagree" to 7 = "strongly agree". The wordings of the items were adapted from the self-efficacy scale developed for the swimming context by Sâmija et al. (2016) by choosing the applicable items and changing their context to skiing. Also, some relevant items focusing more specifically, for example, on skiing technique, were added. Although some of the items shared common themes, the items were not, as such, intended as measures of specific broader constructs related to self-efficacy. Therefore, the responses were examined on the item level rather than aggregating the responses and looking at them on the construct level. In addition, the survey questionnaire contained five items measuring the attitude towards digital coaching by using a seven-point semantic differential scale. The order of the items was randomised for each participant, and responding to the items was non-mandatory, meaning that also missing values were possible.

At the beginning of the study, there were 25 participants in the intervention group and the 15 participants in the control group. However, during the study, two participants from the intervention group had difficulties using the digital coach with their mobile phone due to technical reasons. Therefore, these participants had to be excluded from the study, which resulted in a final sample size of 38 participants, of whom 23 were in the intervention group and 15 were in the control group. Table 1 reports the descriptive statistics of this sample. In terms of gender, the whole sample and the two sub-samples were practically perfectly balanced. The age of the participants at the beginning of the study ranged from 21 to 63 years, with the mean age being 43.0 years (SD = 10.9 years) in the whole sample, 44.3 years (SD = 9.5 years) in the intervention group, and 41.1 years (SD = 12.7 years) in the control group. Most participants in the intervention group were doing the 50 km distance, whereas the 30 km distance was slightly more popular in the control group. The experience level of the participants in skiing ranged from previous or current competitive skiers to those who were doing a long-distance ski race for the first time. Regardless of their skiing experience, all the participants were physically very active. We collected information on the participants' physical activity by using a scale based on the Finnish National Sport Survey (FNSS) (Finnish Sports Federation, 2011), which consisted of seven categories.

The categories in the order from the most active to the least active were competition athletes, fitness athletes, fitness participants, health enhancing participants, utilitarian participants, casual participants, and inactive or sedentary people. In both groups, most categorised themselves as fitness participants.

	Whole sample (N = 38)		Intervention group (N = 23)		Control group (N = 15)	
Gender						
Male	19	50.0	11	47.8	8	53.3
Female	19	50.0	12	52.2	7	46.7
Age						
21–30 years	6	15.8	2	8.7	4	26.7
31–40 years	10	26.3	6	26.1	4	26.7
41–50 years	13	34.2	9	39.1	4	26.7
51–60 years	6	15.8	5	21.7	1	6.7
61–70 years	3	7.9	1	4.3	2	13.3
Skiing distance						
30 km	11	28.9	2	8.7	9	60.0
50 km	27	71.1	21	91.3	6	40.0
Skiing style						
Classic	31	81.6	0	0.0	8	53.3
Skate	7	18.4	23	100.0	7	46.7
Physical activity						
Competition athletes	8	21.1	4	17.4	4	26.7
Fitness athletes	21	55.3	13	56.5	8	53.3
Fitness participants	9	23.7	6	26.1	3	20.0

Table 1. Descriptive statistics of the whole sample and the two sub-samples.

The collected data was analysed by using the IBM SPSS Statistics 24 software. Because of the small sample size and the non-normal distributions in some of the items, the statistical significance of the changes between the measurements were tested by using the non-parametric Wilcoxon (1945) signed-rank test instead of the parametric Student's paired-samples t-test. As a threshold of statistical significance, we used $p < 0.05$. The potential missing values were handled by excluding the response of a particular participant to a particular item if he or she had not responded it in both the surveys. In other words, no imputation was used.

4 Results

The results are presented in three sub-sections, of which the first concentrates on the self-efficacy regarding overall skiing ability, the second concentrates on the self-efficacy regarding the upcoming race performance, and the third concentrates on the attitude towards digital coaching. For each item, we report separately for the intervention group (in white) and the control group (in grey) the mean and the standard deviation of the measurements, the mean change between the measurements and its standard deviation, as well as the results of the Wilcoxon signed-rank test in terms of the standardised z statistic and the p value, with the statistically significant changes as bolded.

4.1 Self-efficacy regarding overall skiing ability

The self-efficacy regarding overall skiing ability was measured by 17 items. Of them, six items concentrated on the self-efficacy regarding the ability to analyse and improve one's skiing and to create a suitable training program for oneself. The results of these measurements are reported in Table 2. As can be seen, statistically significant changes between the measurements were found in two items. First, the knowledge on how one should improve one's skiing technique had increased in the intervention group, whereas practically no change was found in the control group. Second, the perception that it is difficult for oneself to find out how to improve one's skiing technique had decreased in the intervention group. In contrast, this perception seemed to have increased in the control group, but the change remained as statistically not significant.

Statement	N	Survey 1		Survey 2		Change		Wilcoxon test	
		Mean	SD	Mean	SD	Mean	SD	z	p
I do not know how to become a better skier	22	3.1	1.5	2.6	1.1	-0.5	1.6	-1.824	0.068
	15	2.5	1.6	2.9	1.2	0.4	1.2	-1.540	0.124
I know how I should improve my skiing technique	23	3.9	1.1	5.2	1.1	1.3	1.2	**-3.464**	**0.001**
	15	4.6	1.7	4.7	1.4	0.1	0.9	-0.302	0.763
It is difficult for me to find out how to improve my skiing technique	22	4.6	1.5	3.8	1.7	-0.8	1.7	**-2.160**	**0.031**
	15	2.7	1.6	3.5	1.7	0.8	2.3	-1.389	0.165
It is difficult for me to analyze my skiing technique	23	4.4	1.3	4.5	1.6	0.1	1.0	-0.263	0.793
	15	3.3	1.7	3.7	1.5	0.5	2.0	-0.945	0.344
I am able to create a training program that is suitable for me	23	4.3	1.5	4.3	1.6	0.1	1.2	-0.209	0.834
	14	4.7	1.5	4.6	1.2	-0.1	1.2	-0.439	0.660
I need help in creating a training program suitable for me	23	4.7	1.5	4.7	1.5	0.0	1.0	-0.165	0.869
	15	4.2	2.0	4.5	1.7	0.3	1.4	-1.016	0.310

Table 2. Changes in the self-efficacy regarding the ability to analyse and improve skiing and create a suitable training plan.

In turn, the remaining 11 items concentrated on the self-efficacy regarding one's overall skiing technique. The results of these measurements are reported in Table 3. As can be seen, statistically significant changes between the measurements were found in three items. First, the perception that one's skiing technique in diagonal stride (diagonal stride and double polling are both techniques of classic style skiing) is good had decreased in the control group. In contrast, this perception seemed to have increased in the intervention group, but the change remained as statistically not significant. Second, the perception that one's skiing technique is good enough so that one can modify it to fit the circumstances had increased in the intervention group, whereas practically no change was found in the control group. Third, the perception that skiing would feel more pleasant if one had better technique had increased in the intervention group. A similar increase was found also in the control group, but this change remained as statistically not significant.

Statement	N	Survey 1		Survey 2		Change		Wilcoxon test	
		Mean	SD	Mean	SD	Mean	SD	z	p
I am satisfied with the level	23	4.1	1.4	4.3	1.4	0.3	1.5	-0.794	0.427

of my skiing technique	15	5.1	1.8	4.7	1.4	-0.4	1.3	-1.150	0.250
My skiing technique in classic style is good	23	5.0	1.0	5.3	1.0	0.3	1.1	-1.084	0.279
	13	5.5	1.3	5.2	1.1	-0.4	0.7	-1.890	0.059
My skiing technique in skate style in good	22	4.0	1.7	4.2	1.7	0.3	1.0	-1.540	0.124
	13	4.8	2.0	4.4	1.9	-0.5	1.6	-0.954	0.340
My skiing technique in diagonal stride is good	23	4.7	1.2	5.1	1.1	0.4	0.9	-1.897	0.058
	13	5.8	1.1	5.0	1.4	-0.8	1.1	**-2.326**	**0.020**
My skiing technique in double poling is good	23	4.8	1.3	4.7	1.2	-0.1	1.2	-0.294	0.768
	12	5.2	1.3	5.3	0.8	0.2	0.8	-0.707	0.480
My skiing technique is better than a year ago	23	4.3	1.8	4.9	1.7	0.5	1.5	-1.562	0.118
	15	4.4	1.9	4.7	1.2	0.3	1.3	-0.997	0.319
My skiing technique is worse than a year ago	23	2.1	1.2	1.9	1.0	-0.3	1.1	-1.153	0.249
	15	1.9	1.2	2.0	1.0	0.1	1.1	-0.144	0.885
My skiing technique is good enough so that I can modify it to fit the circumstances	23	4.7	1.3	5.2	1.0	0.5	1.1	**-2.000**	**0.046**
	15	5.6	1.1	5.5	1.2	-0.1	0.7	-0.707	0.480
Physical fatigue does not affect my skiing technique	23	2.3	0.9	2.6	1.6	0.3	1.4	-0.884	0.376
	15	3.0	1.3	2.5	1.2	-0.5	1.2	-1.427	0.154
Improving my skiing technique would make me a significantly better skier	23	5.8	1.2	5.8	1.3	0.0	1.1	-0.074	0.941
	15	4.9	1.5	4.9	1.6	-0.1	1.9	-0.918	0.359
Skiing would feel more pleasant if I had a better technique	22	4.8	1.8	5.5	1.5	0.8	1.6	**-1.992**	**0.046**
	13	4.4	2.0	5.4	1.4	1.0	1.9	-1.736	0.083

Table 3. Changes in the self-efficacy regarding overall skiing technique.

So, in summary, the usage of a digital coach seemed to promote both the self-efficacy regarding the ability to analyse and improve one's skiing and the self-efficacy regarding one's overall skiing technique. These findings also gained support from three additional items in the second survey, in which the participants were asked whether they perceived that their skiing technique, their knowledge about their skiing technique and training, and their physical skiing fitness had improved during the past month. Here, about 65 % of the intervention group but only about 20 % of the control group reported an improvement in their skiing technique, whereas about 70 % of the intervention group but only about 33 % of the control group reported of an improvement in their knowledge about their skiing technique and training. In terms of physical skiing fitness, the difference was less considerable as both about 74 % of intervention group and about 67 % of the control group reported of an improvement.

4.2 Self-efficacy regarding upcoming race performance

The self-efficacy regarding the performance in the upcoming race was measured by a total of 13 items. Of them, three items concentrated on the self-efficacy regarding one's physical fitness in the upcoming race. The results of these measurements are reported in Table 4. As can be seen, statistically significant changes between the measurements were found in two items. First, the perception that one's physical fitness is good enough for one to be able to have a good race performance had decreased in the control group, whereas practically no change was found in the intervention group. Second, the trust in one's physical fitness considering the upcoming race had increased in the intervention group. In contrast, this trust decreased in the control group, but the change was not statistically significant.

Statement	N	Survey 1		Survey 2		Change		Wilcoxon test	
		Mean	SD	Mean	SD	Mean	SD	z	p
My physical fitness is good enough for me to be able to finish the race	22	6.6	1.1	6.6	1.0	0.0	0.4	0.000	1.000
	15	6.8	0.4	6.9	0.4	0.1	0.5	-0.577	0.564
My physical fitness is good enough for me to be able to get a good race performance	23	5.2	1.2	5.1	1.1	0.0	1.5	-0.213	0.831
	15	5.9	0.8	5.5	1.1	-0.4	0.6	**-2.121**	**0.034**
I trust my physical fitness considering the upcoming race	23	5.3	1.5	5.8	1.0	0.5	1.2	**-1.976**	**0.048**
	15	6.1	1.1	5.7	1.1	-0.4	0.8	-1.732	0.083

Table 4. Changes in self-efficacy regarding physical fitness in the upcoming race.

In turn, three items concentrated on the self-efficacy regarding one's skiing technique in the upcoming race. The results of these measurements are reported in Table 5. As can be seen, statistically significant changes between the measurements were found only in one item. This concerned the perception that one's skiing technique is not preventing one from getting a good competition performance, which had decreased in the control group. In the intervention group, practically no change was found.

Statement	N	Survey 1		Survey 2		Change		Wilcoxon test	
		Mean	SD	Mean	SD	Mean	SD	z	p
My skiing technique is good enough for me to get a good race performance	23	5.2	1.2	5.4	0.8	0.2	1.0	-0.975	0.329
	14	6.0	1.2	5.7	1.1	-0.3	0.6	-1.633	0.102
My skiing technique is not preventing me from getting a good race performance	23	5.0	1.4	5.0	1.2	0.1	1.3	-0.182	0.856
	15	6.3	1.0	5.5	1.2	-0.7	0.7	**-2.810**	**0.005**
My race performance would be considerably better if I improved my skiing technique	23	4.9	1.6	4.8	1.7	-0.1	1.7	-0.087	0.931
	15	3.9	1.9	4.1	1.8	0.2	1.2	-0.730	0.465

Table 5. Changes in the self-efficacy regarding skiing technique in the upcoming race.

Finally, the remaining seven items concentrated on the self-efficacy regarding one's overall race performance. The results of these measurements are reported in Table 6. As can be seen, statistically significant changes between the measurements were found in three items. First, the fear of not reaching one's race goal had increased in the control group. A similar increase was found also in the intervention group, but this change remained as statistically not significant. Second, not being confident about one's own race performance had increased in both the groups. Third, the feeling that one's confidence in one's abilities will not falter during the race had decreased in the control group, whereas practically no change was found in the intervention group.

Statement	N	Survey 1		Survey 2		Change		Wilcoxon test	
		Mean	SD	Mean	SD	Mean	SD	z	p
I will get a better result than in my previous races	15	5.0	1.2	4.8	1.0	-0.2	1.2	-0.604	0.546
	9	5.1	1.5	4.4	1.3	-0.7	1.6	-1.186	0.236
I will reach the race goal I have set for myself	23	5.0	1.1	4.9	0.9	-0.2	1.1	-0.919	0.358
	14	5.7	0.7	5.4	0.7	-0.4	0.8	-1.518	0.129
I am afraid of not reaching	23	2.5	1.4	3.0	1.9	0.5	1.8	-1.383	0.167

my race goal	15	1.7	1.1	2.5	1.0	0.8	1.0	**-2.489**	**0.013**
I am not confident about my own competition performance	23	3.1	1.5	4.1	1.8	1.0	1.6	**-2.528**	**0.011**
	15	1.8	0.9	2.9	1.5	1.1	1.2	**-2.716**	**0.007**
I will not get discouraged during the race	23	5.1	1.6	5.4	1.5	0.3	1.6	-0.660	0.509
	15	6.1	1.0	5.7	1.1	-0.3	0.7	-1.667	0.096
My confidence in my abilities will not falter during the race	23	4.9	1.5	5.0	1.4	0.1	1.5	-0.291	0.771
	15	5.9	1.2	5.1	1.4	-0.9	1.2	**-2.289**	**0.022**
I will be satisfied with myself after the race	23	5.5	1.0	5.5	0.8	0.0	0.6	-0.333	0.739
	15	5.9	0.8	5.7	0.7	-0.2	0.7	-1.134	0.257

Table 6. Changes in the self-efficacy regarding overall race performance.

So, in summary, it seems that the usage of a digital coach promoted the self-efficacy regarding the performance in the upcoming race or at least protected the intervention group from a similar pre-race anxiety that was characteristic especially for the control group.

4.3 Attitude towards digital coaching

The attitude towards digital coaching was measured by five items, which concentrated on the overall attitude (bad vs. good) as well as on the instrumental (useless vs. useful and foolish vs. sensible) and experimental (unpleasant vs. pleasant and uncomfortable vs. comfortable) aspects of attitudinal evaluations. The results of these measurements are reported in Table 6. All in all, the attitude of both the groups was found to be relatively positive. In the first survey, it also seemed to be slightly more positive in the intervention group than in the control group. In the second survey, these differences had more or less disappeared as the attitude had changed into less positive in the intervention group and more positive in the control group. However, of these changes, only the change in the foolish vs. sensible scale in the intervention group was found as statistically significant.

Statement	**N**	**Survey 1**		**Survey 2**		**Change**		**Wilcoxon test**	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**z**	**p**
The thought of using a digital coach while skiing during the entire ski season sounds: bad vs. good	22	5.6	1.4	5.1	1.7	-0.5	1.3	-1.530	0.126
	13	4.4	1.7	5.1	1.4	0.7	1.7	-1.667	0.096
The thought of using a digital coach while skiing during the entire ski season sounds: useless vs. useful	22	5.7	1.4	5.2	1.8	-0.5	1.4	-1.327	0.185
	14	4.8	1.7	5.1	1.2	0.4	1.9	-0.425	0.671
The thought of using a digital coach while skiing during the entire ski season sounds: foolish vs. sensible	22	5.7	1.4	5.0	1.7	-0.8	1.3	**-2.434**	**0.015**
	14	4.9	1.4	4.9	1.3	0.1	1.2	-0.439	0.660
The thought of using a digital coach while skiing during the entire ski season sounds: unpleasant vs. pleasant	22	5.4	1.6	4.9	1.5	-0.5	1.5	-1.268	0.205
	14	4.7	1.5	4.6	1.7	-0.1	1.2	-0.491	0.623
The thought of using a digital coach while skiing during the entire ski season sounds: uncomfortable vs. comfortable	22	5.3	1.5	4.9	1.6	-0.4	1.7	-1.010	0.312
	13	4.5	1.9	5.1	1.4	0.6	2.1	-0.794	0.427

Table 7. Changes in the attitude towards digital coaching.

5 Discussion

This study examined the changes in self-efficacy regarding cross-country skiers' perceived skiing abilities as well as their confidence related to an upcoming ski marathon race. The group of 38 volunteer participants consisted of skiers from different age groups and skiing backgrounds. The study was conducted as an intervention study containing both an intervention group and a control group. The measures used in the study were based on psychological measurement of self-efficacy that consisted of two online surveys regarding participants' perceptions regarding their own skills and confidence.

Based on the results it can be seen that using a digital coach had some effects on the participants' perceptions of their skiing technique. After the intervention, the intervention group participants were more knowledgeable on how they should change their skiing technique as well as found it easier to analyse their technique. This suggests that even in the case of more experienced cross-country skiers, a digital coach can be able to increase the knowledge regarding their own techniques.

When participants were asked about their overall confidence regarding the upcoming ski marathon race, both groups seemed less confident just before the race. This indicates the known phenomenon of pre-competition anxiety, which relates to anxiety experienced before a sport performance and is affected by perceived readiness and race goals (Lane et al., 1995). However, negative concerns about their race performance and reaching their goals had increased more in the control group participants. Regardless of the decreased level of confidence in general, the intervention group participants seemed to be equally sure they would not lose confidence in their abilities during the race whereas control group participants were more unsure about maintaining their confidence during the race. The difference in the perceptions of these groups regarding confidence during the race may have been a result of the intervention group's increased level of awareness regarding their skiing technique.

It also seemed that compared to control group participants, intervention group participants suffered less from pre-race competition anxiety regarding their technique. In other words, they did not lose their confidence on their skiing technique just before the race but instead were more confident for example on their skiing technique being good enough and to be able to adjust it based on the circumstances, such as weather conditions. According to Martens et al. (1990) a part of competition anxiety is cognitive anxiety, which is defined as cognitive concerns and negative expectations about oneself related to the situation at hand. In this study, the technique related anxiety can be seen as cognitive anxiety. The increase in self-efficacy regarding skiing technique might have resulted from the increased level of awareness regarding their technique.

Besides changes to perceived skiing technique, the intervention group participants also seemed to be more confident of their physical fitness before the upcoming race. One reason for this could be that using the digital coach made the participants more aware of their training history, which might have affected their self-efficacy. Another possible reason for the increased self-efficacy regarding physical fitness is that the digital coach changed the training routines of participants by increasing the amount or intensity of training.

When participants evaluated the changes in their knowledge and abilities during the intervention time it seemed that using the digital coach had resulted in increased knowledge of skiing technique as well as improvements in skiing technique. However, when examining the changes in participants' attitudes towards digital coaching, the attitudes of intervention group had become slightly less positive, whereas control group experienced a slight increase. Nevertheless, both groups in general had a positive attitude toward digital coaching before and after the interventions. This suggests that digital coaching is perceived by cross-country skiers as a positive tool particularly for enhancing skiing technique. However, due to the slight decrease in the attitude of intervention group, it suggests that digital coach devices and applications could be better developed to meet the skiers' needs and desires even more. As highlighted in previous literature (Yardley et al., 2015) it is important, especially in digital interventions, to have a product that uses a person-based approach. This means that digital coach devices should take into account personal differences and preferences while having an emphasis on autonomy

and independent use. The person-based approach is considered essential in maximising the acceptability as well as effectiveness of interventions (Yardley et al., 2015).

As for our practical implications, to tackle this issue, we propose certain design considerations that would most likely be fruitful for digital coach developers in providing products that better meet the users' needs and desires. First, regarding the known issue of pre-race anxiety, the digital coaches could be implemented with features that aim to reduce this by for example presenting the training history in a positive way to boost the confidence that the user has trained properly. Also, drawing from sports psychology, the digital coach could communicate supportive and calming messages to the user on the days preceding the race. Second, as for the communication during the training sessions and competition, the digital coaches should be designed for glanceability. In other words, the things that the users want to and need to see at different moments of their training and race should be well examined. The information should also be presented in a way that is quickly and easily understandable for the user. Third, to boost the confidence and present the value of using the digital coach, it could present the progress in technique or other measures and further provide an illustration on how this improvement will probably translate into actual performance. For example, the digital coach could present the progress in technique or fitness from the start of the use until the current moment and estimate how much this has increased the ability of the user, for example, by presenting the estimated improvement in a 10km ski or run.

As a theoretical contribution, this study extends the previous research on digital coaching by including a psychological element of self-efficacy to the study. The results support the previous research (Feltz 1988) highlighting the role of performance-based information as a source of self-efficacy information. To our knowledge this is the first study to measure psychological effects of digital coaching for cross-country skiers as well as in the athlete target group in general. Therefore, it provides important insights in to this previously little researched topic by acting as a groundwork for future IS studies. This study also contributes to the research on sport psychology by providing new insight and thus encouraging researchers to study the psychological effects of digital coaching and sport technology in general. From a practical point of view the results of this study offer insights to sport technology companies to further understand the positive and negative effects of digital coaching, particularly as it relates to athletes and their self-efficacy. This may assist sport technology companies in further developing products that meet the needs of this particular target group and make them a more attractive purchase. Besides bringing new insight from the IS perspective, we hope these findings would encourage athletes and coaches to consider the possibility of integrating digital coaching into their training program.

6 Limitations and future research

This study has a few notable limitations. Firstly, the size of the study sample was relatively small consisting of 38 participants. Secondly, there was a difference between the number of participants in intervention and control group. Thirdly, the athletes' self-efficacy for using technology was not taken into consideration in this study. Fourthly, the intervention period was approximately one month, which is relatively short. This limits the findings only to relatively short-term effects. Therefore, in the future similar studies should be conducted with more longitudinal study setting. Regardless of these limitations, statistically significant differences were found in both groups. However, in future it would be interesting to do similar studies with a larger data set which could enable studying the effects at a construct level. Lastly, the digital coach selected for this research was specifically designed for cross-country skiers. There are somewhat different types of digital coaching devices in the market which are meant for different target groups. Since this particular device was designed for cross-country skiing purposes, it should not be assumed that these results are directly applicable to other types of digital coach devices that may focus on other types of feedback and assistance. Because the level of a person's cross-country skiing technique plays such a major role in performance, the results of this study may also not be directly comparable to other sports.

Since this study was an exploratory study regarding the digital coaching in self-efficacy context in an athletic setting, this study is hoping to inspire future studies regarding the topic. As highlighted in previous research (Winstein and Schmidt, 1990), there might be differences for the use and effects between athletes and people who are doing sports more casually. Therefore, it would be interesting to do a similar study with the Racefox Ski application and to compare the results between experienced skiers and less experienced skiers. The future topics could also be related to testing the effects of digital coaching in other types of target groups as well as with other types of devices and applications as well as in other sports. Also, qualitative studies could be done regarding the topic in order to deepen the understanding of digital coaching effects especially from the users' point of views. This would bring important knowledge also to the sport technology companies on how to design and modify their digital coaching devices and applications to better meet the needs and wants of different target groups.

References.

Bandura, A. (1977). "Self-efficacy: Toward a unifying theory of behavioral change." *Psychological Review* 84 (2), 191-215.

Bandura, A. (1982) "Self-efficacy mechanism in human agency." *American Psychologist* 37, 122-147.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Bandura, A. (1998). "Health promotion from the perspective of social cognitive theory." *Psychology and Health* 13 (4), 623–649.

Beauchamp, M. R. and M. A. Eys (2007). *Group dynamics in exercise and sport psychology – Contemporary themes*. New York, NY: Routledge.

Chan, C. B., Ryan, D. A. and C. Tudor-Locke (2004). "Health benefits of a pedometer-based physical activity intervention in sedentary workers." *Preventive Medicine* 39 (6), 1215-1222.

Düking P., Hotho A., Holmberg H-C, Fuss F. and Sperlich B. (2016) "Comparison of Non-Invasive Individual Monitoring of the Training and Health of Athletes with Commercially Available Wearable Technologies." *Frontiers in Physiology* 7 (71), 1-11.

Faghri, P. D., Omokaro, C., Parker, C., Nichols, E., Gustavesen, S. and E. Blozie (2008). "E-technology and pedometer walking program to increase physical activity at work." *The Journal of Primary Prevention* 29 (1), 73-91.

Feltz, D. (1988) "Self-confidence and sports performance." Exercise and Sport Sciences Reviews 16 (1), 423-458.

Feltz, D. and C. Lirgg (2001). "Self-efficacy beliefs of athletes, teams, and coaches." In R. Singer, H. Hausenblas & C. Janelle (Eds.) *Handbook of Sport Psychology*, 2nd ed. (340-361). New York: John Wiley & Sons.

Finnish Sports Federation (2011) *Kansallinen liikuntatutkimus 2009-2010: Aikuis- ja senioriliikunta. [National Sports Survey 2009-2010]* Report, Finnish Sports Federation, Helsinki, Finland.

Halson, S., Peake, J. and Sullivan, J. (2016). "Wearable Technology for Athletes: Information Overload and Pseudoscience?." International Journal of Sports Physiology and Performance, 11(6), 705–706.

Jowett, S. and D. Lavallee (2007). *Social psychology in sport*. Champaign, IL: Human Kinetics.

Kang, M., Marshall, S. J., Barreira, T. V. and J. O. Lee (2009). "Effect of pedometer-based physical activity interventions: a meta-analysis." *Research Quarterly for Exercise and sport* 80 (3),648-655.

Kari, T., Kettunen, E., Moilanen, P. and L. Frank (2017a). "Wellness Technology Use in Everyday Life: A Diary Study." In: *The 30th Bled eConference "Digital Transformation – From Connecting Things to Transforming Our Lives"*, Bled, Slovenia: University of Maribor, p. 279-294.

Kari, T., Koivunen, S., Frank, L., Makkonen, M. and P. Moilanen (2016). "Critical experiences during the implementation of a self-tracking technology". In: *The proceedings of the 20th Pacific Asia Conference on Information Systems (PACIS)*, 27.6.-1.7.2016 (16 pages). Chiayi, Taiwan: AIS.

Kari, T., Koivunen, S., Frank, L., Makkonen, M., and P. Moilanen (2017b). "The expected and perceived well-being effects of short-term self-tracking technology use." *International Journal of Networking and Virtual Organisations* 17 (4), 354-370.

Kettunen, E. and T. Kari (2018). "Can Sport and Wellness Technology be My Personal Trainer?: Teenagers and Digital Coaching." *In the 31th Bled eConference. Digital Transformation : Meeting the Challenges*", Bled, Slovenia: University of Maribor, p. 463-476.

Kranz, M., Möller, A., Hammerla, N., Diewald, S., Roalter, L., Ploetz, T. and P. Olivier (2013). "The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices." *Pervasive and Mobile Computing* 9, 203-215.

Lane, A., Terry, P. and C. Karageorghis (1995). "Antecedents of multidimensional competitive state anxiety and self-confidence in duathletes." *Perceptual and Motor Skills* 80, 911-919.

Liebermann, D., Katz, L., Hughes, M., Bartlett, R., McClements, J. and I. Franks (2002). "Advances in the application of information technology to sport performance." *Journal of Sports Sciences*, 20 (10), 755-769.

Locke, E. A. and G. P. Latham, G (2002). "Building a practically useful theory of goal setting and task motivation: A 35-year odyssey." *American Psychologist* 57 (9), 705-717.

Miyamoto, S. W., Henderson, S., Young, H. M., Pande, A. and J. J. Han (2016). "Tracking health data is not enough: a qualitative exploration of the role of healthcare partnerships and mhealth technology to promote physical activity and to sustain behavior change." *JMIR mHealth and uHealth* 4 (1), e5.

Martens, R., Vealey, R. S. and D. Burton (1990). *Competitive anxiety in sport.* Champaign, IL: Human Kinetics.

Moritz, S., Feltz, D., Fahrbach, K. and D. Mack (2000) "The relation of self-efficacy measures to sport performance: A meta-analytic review." Research Quarterly for Exercise and Sport 71 (3), 280-294.

Racefox (2018) Racefox Ski. URL: https://racefox.se/ski#!sv-ski. (visited on 05/29/2018).

Šamija, I., Sporis, G. and K. Šamija (2016). "Self-efficacy scale construction n and validation in swimming." *Acta Kinesiologica* 10, 33-37.

Schmidt, B., Benchea, S., Eichin, R. and C. Meurisch (2015). "Fitness tracker or digital personal coach: how to personalize training." In: *The 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and ACM International Symposium on Wearable Computers*, 7.-11.9.2017. Osaka, Japan: ACM. p. 1063-1067.

Shields, C. and L. Brawley (2006) "Preferring Proxy-agency:Impact on Self-efficacy for Exercise." *Journal of Health Psychology* 11 (6), 904-914.

Shilts, M. K., Horowitz, M. and M. S. Townsend (2004). "Goal setting as a strategy for dietary and physical activity behavior change: a review of the literature*."American Journal of Health Promotion* 19 (2), 81-93.

Wang, J. B., Cataldo, J. K., Ayala, G. X., Natarajan, L., Cadmus-Bertram, L. A., White, M. M., …and J. P. Pierce. (2016). "Mobile and wearable device features that matter in promoting physical activity." *Journal of Mobile Technology in Medicine* 5 (2), 2-11.

Warraich, M. U. (2016). "Wellness Routines with Wearable Activity Trackers: A Systematic Review." *In: The 10th Mediterranean Conference on Information Systems (MCIS),* Paphos, Cyprus.

Wilcoxon, F. (1945). "Individual Comparisons by Ranking Methods. *Biometrics Bulleting* 1 (6),80-83.

Winstein, C. and R. Schmidt (1990). "Reduced Frequency of Knowledge of Results Enhances Motor Skill Learning." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 16, 677-691.

Xiao, X., Hedman, J., Tan, F., Tan, C-W., Clemmensen, T., Lim, E., Henningsson, S., Mukkamala, R., Vatrapu, R. and J. van Hillegersberg (2017) "Sports Digitalization: A Review and A Research Agenda". *In: ICIS 2017*, Proceedings. 6.

Yardley, L., Morrison, L., Bradbury, K. and I. Muller (2015) "The person-based approach to intervention development: Application to digital health-related behavior change interventions." *Journal of Medical Internet Research* 17 (1), e30

II

CAN DIGITAL COACHING BOOST YOUR PERFORMANCE? – A QUALITATIVE STUDY AMONG PHYSICALLY ACTIVE PEOPLE

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Can Digital Coaching Boost Your Performance? – A Qualitative Study among Physically Active People

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Abstract

The use of sport and wellness technology devices among athletes is highly popular. At the same time the demand for easy to understand, clear, and personalized information is also growing. Instead of numbers, users need and want solutions. Digital coaching can offer solutions for this by providing valuable training data and offering guidance and instructions on how to improve the training. This exploratory study focuses on the experiences, needs, and wants regarding a digital coach application among physically active people, more precisely cross-country skiers. We found that the digital coach was perceived to have motivational elements. It was also viewed having potential to increase the awareness relating to personal performance level and technique as well as bring diversity into training. However, some perceived demotivating elements suggest that future development is needed. Our findings give insights to sport technology companies as well as athletes and coaches about the influence and possibilities of digital coaching among athletes and physically active people.

1. Introduction

Receiving relevant and reliable feedback is an important factor in improvement of physical activity and sports skills. Recent developments in technology, and particularly sport and wellness technology devices, have had a significant impact in the sports field. The information has enabled a new level of training feedback both during and after training sessions, which coaches and athletes consider valuable. The probability of learning increases when an athlete can compare the statistics of an actual movement with the internally expected optimum performance [1]. Therefore, the impact of information technology on physical activity and sport performance seems to be positive for helping athletes develop more effectively.

Feedback sources are considered more effective and relevant during the beginning of the skill acquisition process [2]. Their importance seems to decrease when the level of skill increases. Sport and wellness technology devices providing immediate feedback have been considered to be relevant for recreational, amateur, and professional athletes who are at an initial state of skill acquisition [1]. However, it is important to acknowledge that different people have different needs and wants regarding training feedback. Previous research has suggested that providing too much information, inadequate information, or unnecessary information might cause anxiety and stress to the users [3].

As sport and wellness technology devices become more developed and affordable, more athletes and other physically active people have integrated technology into their training. However, without professional help in interpreting the feedback, inappropriate adjustments in training may be made [4], which could lead to overtraining or even injuries. Therefore, sport and wellness technology companies should not only pay attention to the quality of the feedback but also ensure the information is easy to understand and implement. In previous studies it has been found that sport and wellness technology can increase motivation to exercise by increasing awareness of personal physical activity [5,6,7,8]. However, even if tracking physical activity data can lead to increased awareness, this effect might not be sufficient to maintain the use of sport and wellness technology [9]. Furthermore, this can have an effect on the maintenance of physical activity routines [10].

According to previous research [11,12], users of sport and wellness technology prefer receiving relevant, clear, and easy-to-understand information from their devices and applications. They also appreciate receiving information on how to enhance or maintain their overall wellness and physical activity levels [11,12,13]. Receiving this type of data would likely lead to the use of sport and wellness technology being more goal-oriented [11,12], which can contribute

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to increase in motivation [14]. However, a typical problem with sport and wellness technologies is that they provide feedback through numbers and graphs instead of providing meaningful context and guidance. By providing personalized and more instructional feedback, such as personalized training plans, the devices could increase their users' motivation and goal-orientation towards improving physical activity and wellness and also make users more motivated to continue using the technology.

A prospective solution to serve this demand is digital coaching. Digital coaching refers to a "*service on a technological device that not only gives feedback but also offers advice, suggestions and future steps for a user to follow in the pursuit of their wellness and fitness goals*" [13, p.3]. The demand for digital coaching solutions to address goal-driven and personalized support towards physical activity goals was also recognized by Schmidt et al. [15]. While more traditional sport and wellness technology devices increase awareness based on physical activity feedback, digital coaching solutions are a step ahead. A digital coach can identify user's weaknesses and strengths and generate a personalized training plan for the user [15]. The use of digital coaching in a physical activity setting and its potential for increasing motivation has also been highlighted [13,16,17].

The interest towards digital coaching solutions has increased among different stakeholders. However, because digital coaching solutions are still relatively novel, there has been few studies focusing on the usage experiences or the influence of digital coaching within users. To address this research gap, this study explores: 1. How can a sport and wellness technology digital coach influence physically active people when preparing for a race? and 2. What is the usage experience like and what are the perceptions, suggestions, and wishes regarding a digital coach in sport and wellness setting?. Physically active people are usually already familiar with and active users of sport and wellness technology. Having motivation to maintain physical activity level or improving their performance level, these people form an interesting target group for digital coaching solutions as well as for sport technology companies.

This study was conducted as a qualitative study in a cross-country skiing setting. The study included 25 athletes or otherwise physically active participants partaking in a ski marathon race. The study participants used a digital coach in preparation for the race. After the use period, the participants were interviewed to find insights, experiences, and suggestions for improvement regarding digital coaching. In addition, the theoretical focus was on studying the phenomenon from a motivational and psychological standpoint.

2. Theoretical background

The social cognitive theory by Bandura [18] is used as a theoretical framework for this study. This theory is widely used as a framework in studies regarding motivation and physical activity. Bandura also introduced the concept of self-efficacy as a part of this theory. Self-efficacy refers to a person's beliefs regarding his/her capabilities of performing a specific task. Whereas people with high self-efficacy are more likely to see difficult tasks as challenges and perform better, people with low self-efficacy might avoid doing a task they perceive as being too difficult [18]. There are four different sources of information that affect a person's self-efficacy: performance accomplishments, vicarious experience, verbal persuasion, and physiological states [18]. A person's self-efficacy is also related to his/her motivation; a task perceived as too difficult or too easy compared to the perceived skill level can decrease motivation. However, tasks that are perceived as moderately challenging can produce satisfaction by experiencing achievement [19].

Self-efficacy has an impact on enhancing sport performance and is a both a cause and effect of performance [20]. High self-efficacy has also been shown to accompany low pre-competition anxiety, high personal goals, strong goal importance, and high trait sport confidence [21]. Athletes with a high level of self-efficacy will also put more effort, persist longer, and also participate more frequently, enhancing their performance in sports [18]. Therefore, self-efficacy plays an important role in athletes' daily life.

When talking about motivation, the theory of self-determination [22] is also often discussed. The theory highlights three important components that affect motivation: the need for autonomy, the need for competence, and the need for relatedness. The need for autonomy refers to a person's need to be able to self-regulate their personal behavior. The need for competence refers to a person's need to be able to complete a given task by effectively interacting with the surrounding environment. The need for relatedness refers to a person's need to connect with others. All these components can individually or together facilitate intrinsic motivation. Intrinsic motivation means receiving satisfaction from doing an activity itself [22]. Related to physical activity and sports, having a high level of intrinsic motivation has often been connected with the formation of positive exercise habits as well as pursuing a more physically active lifestyle.

Another concept derived from social cognitive theory is proxy agency [23]. In this theory, people play an active and important role in their self-renewal, self-development, and adaptation by using mechanisms called "agencies". In this theoretical context, an

"agency" means acts done on purpose. Bandura categorized three types of agents: personal agent, collective agent, and proxy agent. Personal agent means that the person him/herself acts as an agent, while the collective agent refers to a community or a group. Proxy agent refers to a situation where a third party acts as an agent on a person's behalf [23,24]. In a physical activity setting, a collective agent could be, for example, a team or a group and a proxy agent could be a coach or a personal trainer.

According to [23], there are three reasons why people use a proxy agent. First, people may feel they do not have the needed skills or knowledge to reach their desired goal. Second, they can perceive that a third person is more capable of facilitating the process towards the desired goal and outcome. Third, though people might have the needed skills and knowledge to pursue their desired outcome, they might want to transfer control of the process to another person since they do not want to have the responsibility of a direct control [25]. In a physical activity setting, using a proxy agent, such as a personal trainer, can help a person to manage environment and task demands as well as help in regulating and controlling exercise behavior. A proxy agent can also help in giving support in lifestyle management and in developing new skills [24]. A proxy agent may also be able to provide social support, which may increase the likelihood of full involvement, enjoyment, and focus [26]. In a sport setting, a proxy agent can influence an athlete's self-efficacy in different ways, such as providing vicarious experiences through examples or using persuasive techniques. Persuasive techniques, such as verbal persuasion, evaluative feedback, expectations, and imagery are widely used by trainers and coaches [21].

In this study, the proxy agency theory is examined from a digital coach point of view, and the concept of proxy agent refers to a sport and wellness technology device or application, which is combined with digital coaching features. Like a human proxy agent, a digital coach can also influence feelings of competence by providing feedback, instructions, and verbal persuasion as well as gathering and showing data about performance accomplishments. A digital coach can also affect feelings of relatedness by providing a tool for social comparison. However, social comparison provided by sport and wellness technology can also negatively affect intrinsic motivation by decreasing feelings of perceived competence [27].

It has been suggested that long term use of a proxy agent can lower the self-regulatory skills of a user which are necessary for independent management of sport and physical activity participation [28]. Compared to using a human proxy agent, a digital coach as a proxy agent requires a certain amount of independence and regulatory skills and therefore encourages the user to practice independence while still in a proxy content. This affects positively the feeling of autonomy. However, since using a digital coach, rather than a human coach, gives more responsibility for the user, the concerns regarding appropriate interpretation and delivery become more present.

3. Methodology

3.1. The digital coach used in this study

The digital coach used in this study was Racefox Ski [29]. Racefox uses a smartphone application and an ECG heart rate monitor style chest belt. The belt is also mounted with an accelerometer pod. The data collected by the pod is transferred to a smartphone in real-time via Bluetooth. The application provides data in real-time on the screen and may also send information to a person's connected headphones [29].

The application provides technique analysis and feedback, training program creation, and real-time exercise monitoring and instruction. The features enable the application to analyze a user's technique, provide objective, measurable feedback on their technique, provide specific feedback on how to improve a user's technique, and automatically generate training programs based on the user's fitness goals.

The technique analysis is performed initially using a timed technique test. The skier's technique is measured with the accelerometer and analyzed in four key performance indices (KPI). The optimal technique values for these KPIs are based on analysis of world-class Norwegian skiers. Distance and heart rate may also be measured. The application displays the KPIs data from the test and a brief text with feedback on the user's technique and some advice on how to improve.

Based on the test data, and optionally the user's goal time for a specific race, a two-week training program can be created, consisting of specific guided interval sessions supplemented with easy skiing sessions. After two weeks, the technique test is performed again, and a new program is created based on the new results. The interval sessions instruct the user to reach a specific value in one of the four KPIs. When a user follows one of the guided workout sessions, they are provided real-time feedback, through headphones or their smartphone's speakers, on whether they are achieving the KPI value during the session. For example, a "positive" or "negative" tone will be made for each double poling stroke the skier makes, based on whether or not they have reached the target KPI. After the session, the application will provide

feedback on the skier's technique and how successful they were in achieving the goals of the workout.

3.2 Data collection and analysis

This study followed a qualitative approach. The target population of the study was physically active cross-country skiers (henceforth referred to as skiers) who participated in a ski marathon race that took place in Finland on March 2018. As the digital coach used in this study is designed for cross-country skiing, skiers were an obvious choice for the target group. The device itself was one of the most advanced digital coaching solutions in the market focusing on improving sport performance. Because aim was also to investigate the digital coach as a race preparation tool, the participants were recruited from race participants.

The race had two optional distances of 30km or 50km which both could be skied in skate or classic style. The study participants were recruited with the help of the ski club that organized the race. The invitation to participate in the study was sent via email by the ski club to approximately 900 skiers already registered for the race. A total of 40 people expressed their interest to take part in the study. Out of these, 25 were doing the race in a classic style and expressed their interest for using a digital coach in training for the race. Since the Racefox digital coach was (at the time of the study) only able to give feedback and instructions regarding classic style skiing, the skiing technique was used as a criterion in participant recruitment. Therefore, the number of participants recruited for the study was 25. However, after the use period, two participants reported having problems using Racefox, and therefore the data collected from them was limited to future suggestions regarding digital coaching whereas the parts regarding user experiences and race preparation were left unanswered.

The age of the participants ranged from 21 to 74 years. The participant group consisted of an almost equal number of male and female participants. Most participants in the study were in the 50km race. The skiing experience level of the participants ranged from current or previous competitive skiers to participants who were doing a long-distance ski race for the first time. All the participants were physically very active regardless of their skiing experience. The information regarding the participants physical activity level was collected by using a scale based on Finnish National Sport Survey [30] and consisted of seven categories. The categories presented in the order from the most active to the least active were: competition athletes, fitness athletes, fitness participants, health enhancing participants, utilitarian participants, casual participants, and inactive or sedentary people. Only one participant had previous experiences regarding digital coaching. All participants had some experience with sport technology and most were using solutions like heart rate monitors or physical activity applications in their everyday training. Table 1 presents more detailed information about the study participants.

Table 1. Sample description

	Participants (N = 25)	
Gender	n	%
Male	12	48
Female	13	52
Age		
21–30 years	3	12
31–40 years	6	24
41–50 years	9	36
51–60 years	5	20
61–70 years	1	4
71–80 years	1	4
Skiing distance		
30 km	2	8
50 km	23	92
Physical activity level		
Competition athletes	4	16
Fitness athletes	14	56
Fitness participants	7	28

All 25 study participants were given a personal Racefox Ski digital coach and were asked to use it in the manner that is most suitable to them. The use period started approximately one month before the ski marathon race and lasted approximately eight weeks. During the use period, data was collected two times. First, all the participants were sent an online survey four days before the race where they were asked questions regarding preparation for the upcoming ski marathon with the digital coach and also about their overall feelings regarding the upcoming ski race. The survey questionnaire was created based on previous literature and the theoretical background with the aim to provide relevant knowledge to answer our research questions. All the participants were asked to answer the survey before the race so that their answers would not be affected by the race results. The second round of data collection took part two to three weeks after the race. This time all the participants were interviewed using a thematic semi-structured interview method.

The interviews were performed over skype, by phone, or in person and lasted 55 minutes on average.

The data was analyzed using thematic analysis which is the most widely used analysis method for qualitative research [31]. Thematic analysis is a method for "identifying, analyzing and reporting patterns (themes) within data" [32, p.79]. It allows describing the data set with rich detail. The guidelines by Braun and Clarke [32] were followed when doing the data analysis process and as recommended, the guidelines were adjusted in order to fit the research aim of the study [32]. The data analysis started by getting familiar with the data and transcribing the relevant parts of the interviews. In the interview phase, the data was already divided into three different parts which were: 1. user experiences, 2. race preparation with a digital coach, and 3. ideal digital coach. All of these themes were individually studied aiming at finding differences, similarities, and commonalities in the responses. Finally, the report was created, which aimed to highlight all the aspects that were considered important by the participants regarding each theme.

4. Results

This section introduces the key aspects participants considered important regarding digital coaching. The results are presented in three themes starting from user experiences, followed by race preparation, and finally focusing on the ideas and recommendations the participants had on digital coaching in general.

4.1. User experiences

Almost all the participants reported the initial implementation of the product to be easy. The most often used features in Racefox (henceforth referred to as device) were technique tests and distance training, which were used by almost all participants. More than half of the participants followed the training plan given by the device or at least adapted some recommended training sessions to their own existing training plan. Some participants were not able to or did not want to follow the training plan. Example reasons for this were that the training plan was not suitable and not taking into account the other parts of life and busy schedules. Some participants also highlighted that the training plan could not be adapted based on health reasons, for example when getting a flu during the training period.

A few participants called themselves "performers", meaning they get excited if someone or something gives them a specific plan which they can then follow precisely: *"Training is not goal oriented without a training plan. Having a plan brings a different kind of focus on the training"*. Whereas these "performers" followed the training program received from their digital coach, other participants decided to stick with their old training routine and then see if the digital coach could somehow bring some tips on how they could make their own program more versatile: *"Devices are devices and I decide what I do. If I agree with the device, only then I can do what it says"*. As one participant highlighted, "*training with a new coach requires a conscious decision to be willing to let the coach guide one's training"*.

Around half of the participants tried the real-time feedback function during their training. For all of them this was a feature they had never tried before and it was perceived as a positive and useful feature: *"Real-time feedback really helped me to understand the exact moments when I have to do something differently"*.

All participants were interested in the feedback received from the device. One third of the participants felt the quality of the feedback was high. They thought the feedback was well presented and easy to understand. In particular, the graphical presentation style of feedback was perceived useful. The feedback made them think about their skiing and technique from a different perspective from what they were used to.

Regardless of positive experiences regarding feedback, most of the participants would have liked the feedback to be presented more clearly and felt it was difficult to relate the feedback to their own training and technique. Therefore, they would have liked to be able to ask more specific questions in order to increase their understanding. However, some participants explained that also their level of understanding of what is "good" skiing technique increased the more they used the device. Some participants wanted more detailed feedback since they felt the received feedback was often too similar. Some participants commented that the device was not able to take into account the level of tiredness nor the aim of the ski, meaning whether the ski was meant to be a high-intensity training or just a recovery ski. Therefore, the device was not able to adjust the feedback to the purpose of the training.

The participants were asked about the most positive experiences they had regarding the usage. The most highlighted point was that the digital coach was able to make the training more versatile, for example by offering various interval trainings, which many participants reported they rarely do: *"I did different trainings and it made me push really hard which motivated me a lot. It also gave me suggestions for the following training"*. Participants also appreciated receiving different kinds of data from their skiing, which made them pay more attention to their technique overall. Another highly appreciated feature was the individualized real-time feedback based on the data

from the technique tests. From a technical standpoint, the participants appreciated that the device was quick and easy to start in the beginning of a training session.

Besides positive experiences, participants also shared their negative ones. The biggest negative experiences were related to the functionality of the device. Participants did not always enjoy having to use their phone in cold weather, since taking off their gloves just before and after skiing was somewhat annoying. Issues related to reliability were also often mentioned. Sometimes training sessions were not recorded due to cold weather or loss of the Bluetooth or GPS signal. Some users said that these negative issues made the skiing experience less enjoyable. Some participants said that their motivation for using the device was lowered by the similarity of the received feedback, and that they would have wanted to receive more practical personalized instructions: *"I always received the same feedback. It made me feel I was not able to change my skiing style at all"*. Another remark a few participants made concerned the relationship of the feedback to their own skill level. They wished having a chance to determine own skill level beforehand and based on that, receive feedback adjusted to other skiers with similar skill level instead of being compared to professional skiers. This would require a databank consisting with technique and performance values for different levels of skiers.

In the end of the use period, participants were also asked about their trust towards the digital coach in contrast to other sport technology devices they have used before. Majority of the participants expressed their trust on the actual data received from the digital coach. The trust towards the functionality of the device was also relatively high. Some participants expressed that they trusted the data even more than a feedback received from an actual person. However, the lack of overall knowledge related to the source of the "ideal technique" data as well as having a too complex operating system were reasons that created distrust. Despite perceiving the data as reliable, some participants highlighted the importance of common sense: "*You should always have a filter on when reading information received from a device*".

When asked about digital coaching in general, the participants perceived that the use of a digital coach can positively affect their exercise motivation. The most important factor for increasing motivation seemed to be the ability to monitor performance, receive feedback, and see development over time. Another motivational factor was the possibility to have more variety in training by receiving training advice and suggestions. A third motivational element was having the feeling that someone is always watching and recording training and provides encouragement on a regular basis. Besides the positive factors, the participants also experienced some demotivating elements. If the device did not work properly, training enjoyment could decrease since the focus is more on technical issues rather than actual performance. Some participants perceived that having a constant reminder and observer might create stress to some users. A digital coach might also turn the focus too much on performance improvement, which might lead to overtraining. As one participant expressed, having a right mindset is important: "*The device does not tell me what to do, it is me who makes the decisions".*

4.2. Preparing for a race

Since the first month of the use period occurred while the participants were preparing for the race, they were also asked how using digital coaching affected their race preparation. Most participants reported having had a slightly different race preparation from using of digital coach. The device encouraged them to do more interval training instead of familiar longer steady paced trainings. Around two thirds of the participants reported to have made changes to their race preparation routines. These changes included more training sessions, more physically intensive trainings, or more specific types of technique trainings. Using the digital coach helped several participants learn more about skiing technique in general and helped them pay more attention to skiing technique. Some participants reported having been more focused during training sessions. In particular, exercises related to double poling were utilized by many participants. Some mentioned seeing development in their double poling technique, which gave them confidence for the race since the last part of the course was suitable for double poling technique. One of the participants also felt a confidence boost during the race: "*In the race I felt that unlike previous years, I was more confident in my skiing ability when comparing myself to others. My technique was better due to Racefox. A coach would not have been able to give me this information*".

Using a digital coach during race preparation seemed to increase the motivation to train for some participants by providing encouragement and offering ready-made exercises. Some participants reported that technical usability problems decreased their motivation over time or even made training feel negative.

Participants were also asked about they thought using a digital coach had affected their self-efficacy regarding the race. Slightly less than half reported feeling more confident about the race from using the digital coach. This increased confidence came from perceived improvement of skiing technique, received assurance of the level of one's own skiing technique,

the assurance of being able to change the skiing technique according to different conditions and the positive verbal persuasion received from the device. One participant stated: "*I received more confidence when I heard 'You are a good skier'. I knew that, but it was nice to hear it from somebody else".* Only one participant reported a negative influence on confidence for the race due to the digital coach: *"The trainings felt hard. I got a feeling that how can I ever survive the race if I am not even able to survive these trainings".*

Regarding race preparation, several participants stated that it would have been better to use the digital coach for longer than only one month before the race. Due to the short timeframe, some participants wanted to stick to their own familiar training routine and used the digital coach only to bring extra flavor to the training. Participants highlighted that having the coach for a longer time would have provided a better chance to see the actual development, which might have influenced their self-efficacy even more. For one participant having not enough time before the race had negative results: *"Too short time caused stress. You have to allocate time for learning to use the device."*

Finally, participants were asked how essential and important they see the use of a digital coach when preparing for a race. Around one third did not see the role of a digital coach as notably important and said they would rely more on personal experience and personal feeling as well as already established race preparation routines. A bit less than one third considered using a digital coach important in race preparation by giving tips in improving technique, providing a training plan, giving guidance regarding race preparation, and increasing motivation to train. They said they would be willing to pay for the product in its current form. The rest appreciated the benefits and the potential of a device like Racefox, but did not necessarily see the device, in its current form, as being essential. In general, the participants felt that the two main target groups who would benefit most from using a digital coach in race preparation would be people with less experience and people who want to compete and are aiming at improving their performance.

4.3. The ideal digital coach

After testing the digital coach device for approximately eight weeks, the participants had some idea what digital coaching can be like. After the experience, the participants were asked to describe their ideal digital coach. The most recommended option was a watch combined with an optical heart rate sensor or a heart rate belt. The most important factor highlighted regarding usability was that the device should be as light and unobtrusive as possible and easy to operate mid-exercise. Therefore, most people felt a phone application to be sub-optimal since they prefer to not carry their phone while exercising. For some, even wearing a chest belt felt too oppressive. Some participants said they would like to see the exercise data from a computer and suggested an automatic data transfer from the digital coach to a computer.

Since the importance of high quality and accurate feedback had stood out already regarding user experiences, the participants had suggestions on how their ideal digital coach would give feedback. The most preferred way of receiving feedback during the training was via audio. However, post-training, participants wished to have text feedback which could be seen both from a computer and the device. Some participants also wished additional simplified feedback represented with numbers, graphics, or even emojis. However, this feedback would also need to be paired with more in-depth explanations and suggestions expressed in text form. Overall, personalized and accurate feedback was considered important combined with easy to understand personalized instructions.

The most important reason for participants to use a digital coach was to be able to improve their performance. This could be done by making training more systematic and planned and by providing ways to increase the overall knowledge of training and person's individual characteristics. Besides technique, training, and performance related feedback, some participants also wanted recovery related feedback from their ideal digital coach. Recovery related feedback would include tips for nutrition, hydration, and rest. However, general advice or instructions regarding diet, nutrition, or sleep were not considered necessary by most of the participants since these were considered being part of the knowledge they already had. Only a few were interested in including daily activity monitoring for their ideal coach. One participant suggested adding imagery related mental training exercises.

Regarding having the right attitude, one participant made a development proposal: "*The devices should have different personalities, such as encouraging or demanding, designed for different types of people. The devices could be branded with personas and use those in marketing*."

Finally, participants gave their preferences and perceptions when comparing a digital coach to a human coach. Just over half reported they would use a digital coach over a human coach in their current situation, while less than one third preferred a human coach. The rest wished they could use a combination of human and digital coach. The reason for choosing a digital coach was to be independent in scheduling training, since the digital coach would always be available. The digital coach was also seen as a more

affordable option. Some participants perceived a digital coach having a larger and more science-based knowledge, which makes the information more reliable. Also, receiving constant real-time feedback was perceived as an advantage. While the information received from a digital coach was perceived as more objective, human coaches were considered advantageous in their ability to have a more holistic view of the person. This enables the coach to make changes to the training program based on factors such as life outside training, emotional states, or physical injuries. A human coach can also provide more information and instructions on request, and through personal interaction, motivate each individual in a way that is most suitable and effective for them.

5. Discussion

The purpose of this study was to explore physically active people's experiences regarding digital coaching by focusing on the following questions: 1. How can a sport and wellness technology digital coach influence physically active people when preparing for a race? and 2. What is the usage experience like and what are the perceptions, suggestions, and wishes regarding a digital coach in sport and wellness setting?

The findings indicate that physically active people are interested in digital coaching as a way to improve their sport performance. Digital coaching solutions are generally perceived as interesting, possessing potential to enhance the quality of training and performance by focusing on personalized feedback and guidance. On average, participants found using a digital coach motivating, supporting previous research [16,17], but also negative motivating factors were found.

A digital coach can be a useful tool in race preparation. It can change normal training routines by adding more specific, intensive, and somewhat more efficient trainings. While most participants perceived this positive and motivational, a change in routines can also be seen stressful especially if there is not enough time to adjust. Following a personalized training program can also help in getting into better physical shape. Receiving personalized feedback can increase the awareness of technique, which leads to higher focus on trainings. In particular, real-time feedback was perceived as helpful. Seeing improvements in technique can also increase confidence regarding an upcoming race. This suggests that the increased awareness of personal technique and the feedback of improvement can positively affect self-efficacy regarding an upcoming race, supporting the findings of [33]. Therefore, it can be concluded that a digital coach is able to affect the level of self-efficacy through showing data of performance accomplishments and providing verbal persuasion.

In terms of the proxy agency theory, the biggest reason why physically active people would want a digital coach is that they perceive that a digital coach can bring extra knowledge and instructions and therefore is more capable of facilitating the process towards the desired goal and outcomes. Another reason physically active people can be interested in digital coaching would be the possibility to give responsibility of planning the training to somebody else. This would give extra time within their schedule as well as reduce the level of stress. For some people having being told what to do can even bring extra motivation. On the other hand, the reasons some people are not excited about digital coaching seem to relate to already having a large amount of information acquired from many years of experience or having little desire to improve their performance level.

The biggest reasons why physically active people would prefer their personal trainer to be a sport and wellness technology device rather than a real person, is that the devices are perceived as easy, flexible, and affordable. The users did not want to be dependent on anyone else, and a device can be used whenever needed. Also, the objective, accurate, and comparable information based on scientific background is seen as an advantage. However, the lack of human elements, such as the ability to communicate and detect feelings, or to understand the relationship between training and personal life seems to decrease the attractiveness.

From the self-determination theory standpoint, these results suggest that a digital coach can be seen motivational by increasing feelings of autonomy. By providing an opportunity to see personal development through objective data, a digital coach can also affect the feeling of perceived competence. However, based on the results, a digital coach can also have negative effects on motivation, for example, if the feeling of competence is lowered due negative or unclear feedback from the digital coach.

As a practical contribution, we present implications for future development of digital coaches. A key issue is to further increase the level of personalized feedback and instructions while integrating human elements into the digital coaching solutions. For example, users could be given an opportunity to personalize the style of feedback to better match their personality. Improvements related to usability and personalized feedback might further increase the positive motivational affects and diminish the negative ones.

Based on the findings, the experiences, wants, and needs regarding digital coaching vary between different people. However, the two main target groups seen as most potential for digital coaching are people

with lower sports skill levels and people who, despite already being skillful and competitive, want to further improve their performance. For physically active people the usability factors also seem to play an important role. It is essential that the device is unnoticeable and does not hinder the sport activity. It is also important that the digital coach is easy to use during the training and that the use does not cause interruptions or make the training feel less enjoyable.

Professionals working on sport and physical activity settings could also benefit from integrating digital coaching solutions in their interventions. Yardley et al. [34] highlighted that it is important, especially in digital interventions, to have a product that uses a person-based approach while also having an emphasis on independent use and autonomy. This is considered essential in maximizing the effectiveness and acceptability of interventions [34]. Based on our findings, a combination of a digital coach and a human coach is recommendable. A human coach can help in analyzing the results received from the digital coach, and the device can also give the coach more in-depth knowledge about the user. This makes personal trainers a potential target group for digital coaching products.

6. Limitations and future research

This study has a few notable limitations. First, the use period was approximately eight weeks, including only one-month time for race preparation. This limits the findings to a relatively short-term experience. However, the use period was long enough for the participants to get an idea about the capabilities of having a digital coach as a trainer. Regardless, future studies could be done with longer use periods. Second, the digital coach used in this study was specifically designed for cross-country skiing. Thus, it should not be assumed that these results are directly applicable to other types of digital coaching solutions that may focus on other types of feedback and assistance or are meant for different target groups. Also, because the level of a person's cross-country skiing technique plays such a major role in performance, the results of this study may also not be directly comparable to other sports.

Regardless of these limitations, using a digital coach encouraged the participants to think about the concept of digital coaching in general which helped them to express their needs, motives, and wants related to this topic. The findings regarding user motives and suggestions for product development can be applied to other devices targeted for these types of people. This study is among the first to study the topic of digital coaching with athletes and physically active people, and more research in this field should be done. Future studies could focus on measuring the actual effects sport and wellness related digital coaching has on sport performance, motivation, or self-efficacy within different target groups. Since the results revealed also some elements affecting motivation negatively, special focus in future studies could be on these elements. Overall, the topic of digital coaching within people of any level of physical activity continues to be an important topic of research.

7. References

[1] D. Liebermann, L. Katz, M. Hughes, R. Bartlett, J. McClements and I. Franks, "Advances in the Application of Information Technology to Sport Performance", Journal of Sports Sciences, 20(10), 2002, pp. 755-769.

[2] C. Winstein and R. Schmidt, "Reduced Frequency of Knowledge of Results Enhances Motor Skill Learning", Journal of Experimental Psychology: Learning, Memory, and Cognition, 16, 1990, pp. 677-691.

[3] S. Halson, J. Peake and J. Sullivan, "Wearable Technology for athletes: Information Overload and Pseudoscience?" International Journal of Sports Physiology and Performance, 11(6), 2016, 705–706.

[4] P. Düking, A. Hotho, H-C. Holmberg, F. Fuss and B. Sperlich, "Comparison of Non-invasive Individual Monitoring of the Training and Health of Athletes with Commercially Available Wearable Technologies." Frontiers in Physiology, 7 (71), 2016, pp. 1-11.

[5] M. Kang, S.J. Marshall, T.V. Barreira and J. O. Lee, "Effect of Pedometer-based Physical Activity Interventions: a Meta-analysis" Research Quarterly for Exercise and Sport, 80(3), 2009, pp. 648–655.

[6] T. Kari, T. J. Piippo, L. Frank, M. Makkonen and P. Moilanen, "To gamify or not to gamify?: Gamification in Exercise Applications and Its Role in Impacting Exercise Motivation", Proceedings of the 29th Bled eConference, Bled, Slovenia, University of Maribor, 2016b, pp. 393–405.

[7] T. Kari, E. Kettunen, P. Moilanen and L. Frank, "Wellness Technology Use in Everyday Life: A Diary Study", Proceedings of the 30th Bled eConference: Bled, Slovenia, University of Maribor, 2017a, pp. 279-294.

[8] J.B. Wang, J.K. Cataldo, G.X. Ayala, L. Natarajan, L.A. Cadmus-Bertram, M.M. White…and J.P. Pierce, "Mobile and Wearable Device Features that Matter in Promoting Physical Activity", Journal of Mobile Technology in Medicine, 5(2), 2016, pp. 2-11.

[9] S.W. Miyamoto, S. Henderson, H.M. Young, A. Pande and J.J. Han, (2016). "Tracking Health Data is Not Enough: a Qualitative Exploration of the Role of Healthcare Partnerships and mHealth Technology to Promote Physical

Activity and to Sustain Behavior Change", JMIR mHealth and uHealth 4(1), 2016, pp. e5.

[10] M.U. Warraich, "Wellness Routines with Wearable Activity Trackers: A Systematic Review", Proceedings of the 10th Mediterranean Conference on Information Systems (MCIS), Paphos, Cyprus: AIS, 2016.

[11] T. Kari, S. Koivunen, L. Frank, M. Makkonen and P. Moilanen, "Critical Experiences During the Implementation of a Self-Tracking Technology", Proceedings of the 20th Pacific Asia Conference on Information Systems (PACIS), Chiayi, Taiwan: AIS, 2016a.

[12] T. Kari, S. Koivunen, L. Frank, M. Makkonen and P. Moilanen, "The Expected and Perceived Well-being Effects of Short-term Self-tracking Technology Use", International Journal of Networking and Virtual Organisations, 17(4), 2017b, pp. 354-370.

[13] E. Kettunen and T Kari. "Can Sport and Wellness Technology be My Personal Trainer? – Teenagers and Digital Coaching", Proceedings of the 30th Bled eConference, Bled, Slovenia, 2018.

[14] M. K. Shilts, M. Horowitz and M.S. Townsend, "Goal Setting as a Strategy for Dietary and Physical Activity Behavior Change: a Review of the Literature", American Journal of Health Promotion, 19(2), 2004, pp. 81-93.

[15] B. Schmidt, S. Benchea, R. Eichin and C. Meurisch, "Fitness Tracker or Digital Personal Coach: How to Personalize Training." Proceedings of the ACM International Joint Conference on Pervasive and Ubiquitous Computing and ACM International Symposium on Wearable Computers, Osaka, Japan: ACM, 2015, pp. 1063-1067.

[16] M. Kranz, A. Möller, N. Hammerla, S. Diewald, L. Roalter, T. Ploetz and P. Olivier, "The Mobile Fitness Coach: Towards Individualized Skill Assessment Using Personalized Mobile Devices" Pervasive and Mobile Computing 9, 2013, pp. 203-215.

[17] T. Kari and P. Rinne. "Influence of Digital Coaching on Physical Activity: Motivation and Behaviour of Physically Inactive Individuals", Proceedings of the 31st Bled eConference, Bled, Slovenia, 2018.

[18] Bandura, A., Social Foundations of Thought and Action: A Social Cognitive Theory, Englewood Cliffs, NJ: Prentice-Hall, 1986.

[19] A. Bandura, "Health promotion from the Perspective of Social Cognitive Theory", Psychology and Health, 13(4), 1998, pp. 623–649.

[20] S. Moritz, D. Feltz, K. Fahrbach, and D. Mack, "The Relation of Self-efficacy Measures to Sport Performance: A Meta-analytic Review", Research Quarterly for Exercise and Sport, 71(3), 2000, pp. 280-294.

[21] D. Feltz and C. Lirgg, (2001). "Self-efficacy Beliefs of Athletes, Team, and Coaches" In R. Singer, H. Hausenblas and C. Janelle (Eds.) Handbook of Sport Psychology, 2nd ed., New York: John Wiley & Sons, 2001, pp. 340-361.

[22] R.M. Ryan and E.L. Deci, "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions", Contemporary Educational Psychology, 25(1), 2000, pp. 54-67.

[23] A. Bandura, "Self-efficacy Mechanism in Human Agency", American Psychologist, 37, 1982, pp. 122-147.

[24] Beauchamp, M. R. and M. A. Eys, Group Dynamics in Exercise and Sport Psychology – Contemporary Themes, New York, NY: Routledge, 2007.

[25] Bandura, A., Self-efficacy: The Exercise of Control. New York, NY: Freeman, 1997.

[26] Jowett, S. and D. Lavallee, Social Psychology in Sport. Champaign, IL: Human Kinetics, 2007.

[27] C. Kerner and V. Goodyear. "The Motivational Impact of Wearable Healthy Lifestyle Technologies: A Self-determination Prospective on Fitbits With Adolescents", American Journal of Health Education, 48(5), 2017, pp. 287-297

[28] C. Shields and L. Brawley, "Preferring Proxy-agency: Impact on Self-efficacy for Exercise", Journal of Health Psychology, 11(6), 2006, pp. 904-914.

[29] Racefox, Racefox Ski, 2018, URL: https://racefox.se/ski#!sv-ski. (visited on 05/29/2018).

[30] Finnish Sports Federation, Kansallinen Liikuntatutkimus 2009-2010: Aikuis- ja senioriliikunta. [National Sports Survey 2009-2010] Report, Finnish Sports Federation, Helsinki, Finland, 2011.

[31] Guest, G., K.M. MacQueen and E.E. Namey, Applied Thematic Analysis. Los Angeles, CA: SAGE, 2012.

[32] V. Braun, and V. Clarke, "Using Thematic Analysis in Psychology", Qualitative Research in Psychology, 3(2), 2006, pp. 77–101.

[33] E. Kettunen, T. Kari, M, Makkonen and W. Critchley. "Digital Coaching And Athlete's Self-Efficacy – A Quantitative Study on Sport and Wellness Technology", Proceedings of the 12th Mediterranean Conference on Information Systems, Corfu, Greece, 2018.

[34] L. Yardley, L. Morrison, K. Bradbury and I. Muller, "The Person-Based Approach to Intervention Development: Application to Digital Health-Related Behavior Change Interventions", Journal of Medical Internet Research, 17(1), 2015, pp. e30.

III

DIGITAL COACHING AMONG UNIVERSITY STUDENTS WITH LOW LEVELS OF PHYSICAL ACTIVITY: A QUANTITATIVE INTERVENTION STUDY ON EXERCISE SELF-EFFICACY

by

Eeva Kettunen, Tuomas Kari, Markus Makkonen, Will Critchley & Anna Sell, 2019

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Digital Coaching among University Students with Low Levels of Physical Activity: A Quantitative Intervention Study on Exercise Self-efficacy

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Abstract University aged people have been found to be at a high risk of disengagement of physical activity. They also belong to a generation where technology is strongly integrated into most parts of their lives. Therefore, using technology also in physical activity promotion has potential. This exploratory study investigates the perceived effects of a sport and wellness technology digital coach among physically inactive university students during a 10-week intervention. The perspective for the research came from exercise psychology focusing on the effects of the use of a digital coach on self-efficacy related to physical activity and exercising. The results indicate that a digital coach can increase the user's self-efficacy and awareness regarding their own exercising. However, the results also show that further development could be done for digital coaching to reach its full potential. These results give more insight to sport technology companies as well as to coaches and trainers about the effects and possibilities of digital coaching among physically inactive people.

Keywords: • Digital wellness • Physical activity • Digital coach • Self-efficacy • Students • Sport and wellness technology • Intervention •

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1 Introduction

People who are of university age have been found to be at high risk of a sedentary lifestyle (Cocca et al., 2014, Downes, 2015). Physical inactivity is also significant problem around the world due its negative effects on overall health and wellbeing (WHO, 2017). In university students, a sedentary lifestyle has been linked to increased levels of anxiety, stress, and depression (Lee & Kim, 2019). As young people transit from secondary school to university, they are at heightened risk of decreased physical activity (Vella-Zarb & Elgar, 2009). Therefore, it is important to find a variety of methods to increase the level of physical activity and to prevent disengagement from physical activity.

Young people who are born between 1977 and 1997, are called the "Net Generation" by Comegys et al. (2006) meaning that they have had a chance to use information technology throughout their entire lives. Most of today's university students also fall into this category. By being familiar with technology and being used to integrate it in different parts of life, it is worth studying whether technology has potential to motivate this generation also towards more physically active lifestyle.

Since sport and wellness technology devices are becoming more popular and less expensive, not only athletes but also regular exercisers have started to combine technology into their training. According to previous research, feedback sources are considered more relevant and effective during the beginning of skill acquisition (Winstein and Schmidt, 1990). Therefore, sport and wellness technologies are suitable also for recreational exercisers who are in the initial level of skill acquisition and whose knowledge level regarding exercising has not reached its peak (Liebermann et al., 2002).

According to previous studies, sport and wellness technology has potential in increasing user's motivation by increasing the level of awareness regarding personal physical activity. (e.g., Chan et al., 2004; Faghri et al., 2008; Kang et al., 2009; Kari et al., 2017a; Wang et al., 2016). However, the increased awareness regarding one's physical activity alone may not lead to maintaining the use of sport and wellness technology (Miyamoto et al., 2016) This might subsequently also affect the overall maintenance of physical activity routines (Warraich, 2016). Adding personalized achievable goals, sufficient usage guidance, and clear and

easy to understand information might increase adherence and help users to maintain their motivation and exercise routines. Receiving feedback on how to enhance or maintain overall wellness and physical activity can make users more goal oriented (e.g., Kari et al., 2016; Kari et al. 2017b), which can lead to increased motivation (Locke and Latham, 2002; Shilts et al., 2004).

Many current sport and wellness technology devices and applications concentrate on giving data and feedback related to past performance and do not provide personalized information or instructions on what to do next. This is problematic considering users who do not possess knowledge and experience about exercising and who would like to rely on instructions received from external sources.

One potential solution for this problem is digital coaching, which refers to a "service on a technological device that not only gives feedback but also offers advice, suggestions and future steps for a user to follow in the pursuit of their wellness and fitness goals" (Kettunen & Kari, 2018, p.3). While more traditional sport and wellness technology devices and applications focus on increasing awareness by giving feedback on performance data, a digital coach goes one step further by creating for the user an individualized training plan. A digital coach can potentially identify the strengths and weaknesses of a user, and also update the personalized training plan based on user's performance and development (Schmidt et al., 2015). The potential of a digital coach regarding physical activity and exercise has also been recognized in other previous research (Kranz et al., 2013; Kari & Rinne, 2018; Kettunen & Kari, 2018; Kettunen et al., 2018; Kettunen et al., 2019).

Since the commercial sport and wellness technology digital coaching devices and solutions are relatively new, there has not been many studies focusing on the effects or the usage experience of this technology. However, since interest towards digital coaching is growing it is worthwhile to continue studying further digital coaching solutions and their effects especially in a physical activity and wellness context.

This study continues the important investigation on the usage experiences of digital coaches focusing more closely on the exercise psychological perspective. More precisely the aim of this study is to find out whether the use of a sport and wellness technology digital coach has an effect on exercise self-efficacy of people who are physically inactive but interested in pursuing more physically active lifestyle. The main research question this study seeks to answer is: *Can the use of a digital coach affect self-efficacy related to physical activity and exercising within physically inactive people?*

The concept of self-efficacy was chosen for the study due to its significant relationship to physical activity performance affecting the choice of activity, effort expenditure, persistence level and vulnerability to stress and depression (Bandura, 1997).

The study included 59 participants who were all physically inactive university students but who were interested in increasing the level of their physical activity. The study lasted for 10 weeks and the participants were divided into intervention and control groups where the intervention group was given a sport and wellness technology digital coach. Online self-assessment surveys were sent to all participants in the beginning, middle and the end of the study period. The survey measured the participants' self-efficacy and opinions related to a digital coach. The findings of the study provide interesting first insights on the use of digital coaching solutions and aim to encourage future research on digital coaching especially from an exercise psychology perspective.

2 Theoretical Background

The theoretical background for this study comes from Alfred Bandura's (1977) theory of self-efficacy. Self-efficacy refers to a person's beliefs regarding his or her own capabilities of performing a specific task. People with high self-efficacy tend to view difficult tasks as opportunities to overcome a challenge, whereas those with lower self-efficacy may tend to avoid tasks that are perceived to be difficult. Motivation may also be affected by self-efficacy because it may affect the amount of effort a person is willing to put in, particularly in the face of obstacles. When there are moderately challenging tasks that can be overcome, people may experience satisfaction of accomplishment and therefore increased

motivation, while motivation may decrease with tasks that are perceived as either too easy or too difficult relative to their own perceived skill level (Bandura, 1998).

Within self-efficacy theory, there are four sources of information that may affect self-efficacy: performance accomplishment, vicarious experience, verbal persuasion, and physiological states (Bandura, 1998). Performance accomplishments are based on positive past performances and are considered the most influential source of self-efficacy. Vicarious experiences are received when observing other people performing a skill. Verbal persuasion simply means receiving comments or feedback from others. Finally, physiological state relates to how a person perceives their physiological reactions to an experience, specifically their emotional arousal, such as their stress reactions from a particular situation. The self-efficacy construct is one aspect of Bandura's social cognitive theory (1986) which suggests that a person's actions, reactions, and social behavior are influenced by their observations of the actions of others. The social cognitive theory highlights the role of social experience and observational learning in personality development and has often been used as a framework theory for studies focusing on motivation and physical activity. Within the field of self-confidence in sports performance studies, the theory of self-efficacy is one of the most widely used.

In this study, the theoretical background of self-efficacy has been studied from the perspective of physical activity and exercise and therefore the focus can be said to be on exercise self-efficacy. Exercise self-efficacy is being studied from the point of view of a person who is not physically active enough but would like to become more physically active and start exercising. The concept of self-efficacy was chosen for the study since it has been demonstrated to have high influence in the adoption of physical activity (McAuley & Blissmer, 2000) and especially during the phase when physical activity has not yet become habitual (Bandura, 1986). Exercise self-efficacy has also been associated with the long-term maintenance of physical activity (McAuley et al., 2011).

People with a high level of self-efficacy will also participate more frequently, put in more effort and also persist longer, enhancing their performance (Bandura, 1986) for example in exercising. Therefore, self-efficacy has an important role in everyday life when trying to improve one's fitness and become more physically

active. Self-efficacy is one of the most widely researched concepts in the field of health promotion (Kroll et al., 2007) and sports performance (Feltz, 1988).

3 Methodology

3.1 The Digital Coach Used in the Study

The device that provided the digital coaching in this study was the Suunto 3 Fitness, created by Suunto Oy (Suunto, 2019). The device is a fitness monitoring watch, which includes wrist-based heart rate detection, exercise timing and stopwatch features, 24/7 activity tracking including sleep monitoring, stress and recovery measurements, step and calorie counting, as well as additional features when pairing the device with Suunto's mobile phone app. The device may also receive speed and distance information from a phone's GPS information.

The Suunto 3 Fitness also includes a digital coaching feature, an adaptive training coach that can provide training instruction directly on the watch. The personalized training plan created in the watch is based on a user's estimated fitness level. The fitness level may be calculated using a guided fitness test, or the device may make an automatic fitness level calculation based on previous workout data. The user can also select a fitness goal, from three options, "maintain", "improve", and "boost", "boost" being a goal that aims to improve fitness level at a faster rate than in the "improve" program. The different goals will change the amount of training load that is recommended, and the goals may also be changed at any time.

Based on the user's fitness level, the device's digital coach will provide a recommendation for the next day's workout. It will also display a general presentation of what the next 7-days of the training program will be, as well as a text list of the workouts. The next workout recommendation may be a rest day, or may be some sort of training target, usually in a measure of time (in minutes), as well as a recommended intensity, usually in the form of "easy", "moderate", or "hard".

When the user performs the recommended workout, the device will provide real-time guidance. The guidance is based on staying within the designated heart rate zones. The watch will have visual indicators showing the user's heart rate and

where it is within the target zone. It will also show a progress bar showing how much of the workout has been completed. If the user's heart rate leaves the recommended the target zone, there will be a visual notification, watch vibration, and the device will provide an audio notification, all of which will specifically tell the user to lower their heart rate (by slowing down), or raise their heart rate (by speeding up). The user will then be notified when the workout has been successfully completed.

The resultant data from the workouts may be used to adjust future workouts, being made harder or easier based on the changing fitness level of the user. This may also include if the user performed the workout and it appeared too easy or too hard. If the user does a completely different workout than the recommended workout, subsequent workouts will also be adjusted to maintain the training targets.

3.2 Data collection and analysis

The study was conducted as an intervention study using an intervention group and a control group. The target population was university students who reported being physically inactive in the sense of not meeting the physical activity recommendations but who wanted to have a more physically active lifestyle. The invitation to take part in the study was sent to all students studying in the authors' universities via student online magazine. The students were also recruited using snowball sampling method. In total, 67 students volunteered to take part in the study. Out of all the volunteers, 7 students did not meet the criteria of being physically inactive enough and were excluded from the study.

The study had two sub groups, an intervention group, including 30 participants and a control group with 29 participants. The control group originally also had 30 participants but one participant dropped out during the study. The first 30 students who expressed their interest in taking part in the study and training with a digital coach and whose background fit the requirements, were chosen for the intervention group. The reason for limiting the number of participants to 30 was due to the number of available digital coach devices. The other suitable students who expressed their interest to take part of the study but were not chosen for

the intervention group, formed a control group. The recruitment process was stopped when 30 participants were found for each sub group.

The duration of the study was approximately 10 weeks. During that time the intervention group was using a digital coach along with their exercising whereas the control group participants did not receive a digital coach. At the beginning of the study, the participants in both groups were surveyed for the first time by using an online survey. After the first survey the intervention group was given the digital coach devices. The participants were asked to use the device in a way that was most suitable for them. Half way through the study, after 5 weeks, both intervention and control group received another online survey. The third and last survey was sent to them in the end of the 10-week intervention.

In the three online surveys, the measurements were conducted identically for both groups. The survey questionnaire contained an exercise self-efficacy scale by Kroll et al. (2007) using a four-point rating scale ranging from 1 = "Not at all true" 4 = "Exactly true". The questionnaires also had 13 items measuring the self-efficacy regarding overall beliefs about exercising in general and about using sport and exercise technology in training. The questions had a seven-point Likert scale ranging from 1 = "strongly disagree" to 7 = "strongly agree". These items were not, as such, intended as measures of specific broader constructs related to self-efficacy, although some of the items shared common themes. Therefore, the responses were examined on the item level instead of looking at them on the construct level. In addition, the survey questionnaire contained five items measuring the attitude towards digital coaching by using a seven-point semantic differential scale. In addition, the surveys contained five items measuring the attitude towards digital coaching by using a seven-point semantic differential scale. In all of the questions in the questionnaire the order of the items was randomized for each participant. Missing values were also possible since responding to the items was non-mandatory.

The participants' ages in the beginning of the study ranged from 20 to 61 years. Information was collected about the participants' physical activity by using a scale based on the Finnish National Sport Survey (FNSS) (Finnish Sports Federation, 2011), which consisted of seven categories. The categories in the order from the most active to the least active were competition athletes, fitness athletes, fitness participants, physically active for health, active in commuting and non-exercise,

occasionally active, and inactive or sedentary. Table 1 reports the descriptive statistics of the sample.

Table 1. Descriptive statistics of the whole sample and the two sub-samples.

	Whole sample (N = 59)		Intervention group (N = 30)		Control group (N = 29)	
Gender						
Male	17	28.8	10	66.7	7	24.1
Female	42	71.2	20	33.3	22	75.9
Age						
< 25 years	14	23.7	8	26.7	6	20.1
25–30 years	18	30.5	8	26.7	10	34.5
31–35 years	11	18.6	6	20.0	5	17.2
36–40 years	7	11.9	5	16.7	2	6.9
40< years	10	16.9	3	10.0	7	24.1
Degree under study						
Bachelor's degree	16	27.1	8	26.7	8	27.6
Master's degree	39	66.1	20	66.7	19	65.5
Doctoral degree	4	6.8	2	6.7	2	6.9
Study mode						
full-time student	40	67.8	21	70.0	19	65.5
part-time student	15	25.4	7	23.3	8	27.6
other	4	6.8	2	6.7	2	6.9
Physical activity						
Fitness participants	8	13.6	0	0	8	27.6
Physically active for health	8	13.6	4	13.3	4	13.8
Active in commuting and non-exercise	24	40.7	17	56.7	7	24.1
Occasionally active	19	32.2	9	30.0	9	31.0
Sedentary	2	3.4	1	3.3	1	3.4

The collected data was analyzed with the IBM SPSS Statistics 24 software. Because of the non-normal distributions in some of the items and small sample size and, the statistical significance of the changes between the measurements were tested by using the non-parametric Wilcoxon (1945) signed-rank test instead of the parametric Student's paired-samples t-test. We used $p < 0.05$ as a threshold of statistical significance. The potential missing values were handled by excluding the responses of a particular participant to a particular item if he or she had not

responded it in all the three surveys. That means that the exact number of respondents (N) may slightly vary per each item.

4 Results

The results are presented in three sub-sections, of which the first concentrates on the overall exercise self-efficacy. The second part focuses on self-efficacy related to improving physical activity and the perceptions about sport and wellness technology related to training. The third section focuses on the attitude about digital coaching. For each item, we report the results of the intervention group (in grey) and the results of the control group (in white) on separate rows. The reported results include the number of respondents (N), the mean and the standard deviation (SD) of the measurements at each of the three time-points, and the p-values of the Wilcoxon signed-rank tests that were used to examine the statistical significance of the change in mean between the first measurement and the second measurement as well as between the first measurement and the third measurement. We have also bolded the changes that are statistically significant at the level of $p < 0.05$.

4.1 Exercise Self-efficacy

Exercise self-efficacy was measured by using the Exercise self-efficacy scale by Kroll et al. (2007). The scale included 10 questions regarding personal abilities in performing physical activity which are presented in the table 2 below. As can be seen from the results the intervention group experienced statistically significant positive results related to many of the questions. This increased self-efficacy was seen for example in finding means to be physically active, in overcoming barriers related to exercising, being able to exercise when feeling depressed, being physically active without a support from friend family or trainer, and being able to continue physical activity after an inactive season. However, the control group experienced a decrease in self-efficacy in being able to meet the set exercise goals and in overcoming possible barriers. Whereas the intervention group also felt more confident in being motivated to exercise even if they were tired, the control group felt less confident about it. It is worth noting that most of the statistically significant changes occurred not within the first half of the study but only when comparing the change throughout the entire intervention.

Table 2. Changes in exercise self-efficacy

Statement	N	Time 1		Time 2		Time 3		p (1 vs. 2)	p (1 vs. 3)
		Mean	SD	Mean	SD	Mean	SD		
I can overcome barriers and challenges with regard to physical activity and exercise if I try hard enough	30	3.3	0.7	3.3	0.8	3.5	0.8	1.000	0.275
	28	3.6	0.6	3.4	0.8	3.4	0.7	0.083	0.334
I can find means and ways to be physically active and exercise	30	2.6	0.8	2.6	0.9	3.2	0.8	1.000	**0.005**
	29	3.0	0.7	3.0	0.8	3.2	0.8	0.819	0.152
I can accomplish my physical activity and exercise goals that I set	30	2.5	0.8	2.6	0.9	2.6	0.9	0.532	0.449
	28	2.3	0.8	2.5	0.8	2.8	0.8	0.052	**0.001**
When I am confronted with a barrier to physical activity or exercise I can find several solutions to overcome this barrier	30	2.4	0.8	2.6	0.9	2.8	0.9	0.130	**0.022**
	27	2.4	0.8	2.5	0.8	2.8	0.7	0.819	**0.025**
I can be physically active or exercise even when I am tired	30	2.1	0.7	2.4	0.9	2.4	1.0	**0.039**	**0.025**
	28	2.6	1.0	2.2	0.7	2.4	0.8	**0.014**	0.251
I can be physically active or exercise even when I am feeling depressed	27	2.3	0.9	2.4	0.9	2.7	0.9	0.384	**0.022**
	23	2.3	0.9	2.4	0.9	2.7	1.0	0.527	0.054
I can be physically active or exercise even without the support of my family or friends	30	3.2	0.9	3.1	1.0	3.6	0.8	0.377	**0.035**
	26	3.3	0.8	3.2	0.9	3.4	0.6	0.248	0.642
I can be physically active or exercise without the help of a therapist or trainer	30	2.7	0.9	2.8	0.9	3.3	0.8	0.674	**0.004**
	27	3.4	0.7	3.3	0.5	3.6	0.6	0.366	0.356
I can motivate myself to start being physically active or exercising again after I've stopped for a while	29	2.4	0.8	2.7	0.7	3.0	0.8	0.077	**0.003**
	28	2.6	0.9	2.7	0.9	2.8	0.8	0.415	0.071
I can be physically active or exercise even if I had no access to a gym, exercise, training, or rehabilitation facility	30	3.2	0.9	3.2	1.0	3.2	1.0	0.523	0.564
	26	3.1	1.0	3.0	0.9	3.1	1.0	0.623	1.000

4.2 Self-efficacy Related to Improving Fitness and sport and exercise technology

The self-efficacy regarding participant's opinions about exercising and improving fitness in general was measured by a total of 13 items. Of them, six items concentrated on the role of sport and wellness technology regarding exercising and improving physical fitness. The results of these measurements are reported in Table 3.

As can be seen, statistically significant changes between the measurements were found in several items. First, the intervention group found it easier after the intervention to analyze their own aerobic fitness as well as felt more confident on knowing how to improve it. After the intervention the intervention group also felt on average more confident in being able to create for themselves an exercise program and were more confident in training independently without any guidance or coaching. Both groups found it easier in the end of the intervention to find out how to improve one's fitness. Secondly, when it comes to the beliefs about sport and exercise technology, the intervention group participants experienced a statistically significant decrease in their belief in reliability and accuracy of sport and wellness technology devices whereas the control group did not have any significant changes in their beliefs. The intervention group also had a statistically significant decrease in their beliefs regarding the usefulness of the data received from the technology and its ability to help in improving fitness. As can be seen form the results, this decrease took place already in the first five-week period during the intervention. Regardless of the decrease the average opinions regarding the above-mentioned statements still stayed more positive than negative.

Table 3. Changes in self-efficacy related to improving fitness and sport and wellness technology

Statement	N	Time 1		Time 2		Time 3		p (1 vs. 2)	p (1 vs. 3)
		Mean	SD	Mean	SD	Mean	SD		
I know how to create myself an exercising program	30	3.0	1.4	3.5	1.6	3.9	1.8	0.092	**0.002**
	29	3.8	1.7	4.0	1.6	4.0	1.6	0.444	0.463
I need help in creating myself a suitable exercising program	30	5.9	1.4	5.0	1.7	4.6	1.6	**0.002**	**< 0.001**
	28	4.6	2.0	4.4	1.5	4.2	1.7	0.591	**0.040**
I am able to train independently without any guidance or coaching	29	3.8	1.6	4.7	1.4	4.9	1.8	**0.003**	**0.001**
	29	5.2	1.4	5.3	1.4	5.4	1.3	0.505	0.313
Sport and wellness technology has an important role in my exercising	30	3.5	1.8	3.9	1.8	3.6	2.0	0.365	0.793
	29	3.3	2.1	3.1	1.8	3.0	1.6	0.473	0.182
Sport and wellness technology provides me with important information that I can use in my exercising	30	5.7	1.2	4.9	1.5	4.9	1.7	**0.027**	0.076
	26	5.4	1.1	5.0	1.5	5.2	1.3	0.310	0.334
I am able to improve my fitness with the help of sport and wellness technology	28	5.4	1.1	4.9	1.6	4.5	1.6	0.103	**0.004**
	24	4.8	1.6	4.8	1.1	4.6	1.5	0.672	0.659
I believe that sport and wellness technology provides me with reliable information regarding my own exercising	30	6.1	0.7	5.0	1.4	5.0	1.6	**0.001**	**0.001**
	28	5.2	1.4	5.3	1.4	5.5	1.2	0.542	0.187
I believe that sport and wellness technology provides me with accurate information regarding my own exercising	30	6.0	0.9	5.0	1.6	4.9	1.6	**0.002**	**0.002**
	27	5.6	1.3	5.1	1.4	5.3	1.1	0.106	0.425
I believe that sport and wellness technology provides me with truthful information regarding my own exercising	30	6.1	0.8	5.0	1.5	5.1	1.5	**0.001**	**0.003**
	29	5.2	1.6	52	1.4	52	1.2	0.814	0.869
It is hard for me to find out how to improve my aerobic fitness	29	3.2	1.9	2.7	1.7	2.4	1.6	0.123	**0.027**
	28	3.0	1.9	2.6	1.5	2.3	1.2	0.300	**0.022**
	30	2.9	1.5	2.5	1.6	2.4	1.5	0.174	0.085

I do not know how to increase the level of my aerobic fitness	28	2.3	1.7	2.2	1.3	2.3	1.2	0.912	0.831
It is hard for me to analyze my aerobic fitness	30	4.7	2.0	4.2	2.0	3.8	1.9	0.316	**0.005**
	28	3.9	1.8	3.8	1.7	3.9	1.4	1.000	1.000
I know how to improve my aerobic fitness	29	4.3	1.8	5.0	1.6	5.0	1.6	**0.047**	0.058
	29	5.6	1.5	5.3	1.3	5.3	1.3	0.330	0.469

4.3 Attitude towards digital coaching

The attitude towards digital coaching was measured by five items. These items concentrated on the overall attitude (bad vs. good) as well as on the experimental (unpleasant vs. pleasant and uncomfortable vs. comfortable) and the instrumental (useless vs. useful and foolish vs. sensible) aspects of attitudinal evaluations. The results of these measurements are reported in Table 4 below. When looking at the results it can be seen that the attitude in the intervention group experienced a statistically significant decrease when comparing the time throughout the entire intervention period. This change was not statistically lower when compared the results within the first five weeks, meaning that the more significant changes in attitude took place in the second five-week part of the intervention. There was no statistically significant change in the control group.

Table 4. Changes in attitude towards digital coach

Statement	N	Time 1		Time 2		Time 3		p (1 vs. 2)	p (1 vs. 3)
		Mean	SD	Mean	SD	Mean	SD		
The thought of using a digital coach as a support for my training sounds: bad vs. good	30	6.4	0.8	5.9	1.1	5.2	1.7	0.078	**0.003**
	29	5.3	1.3	5.4	1.2	5.3	1.5	0.591	0.791
The thought of using a digital coach as a support for my training sounds: useless vs. useful	30	6.3	0.8	6.0	1.0	4.8	1.9	0.192	**0.002**
	29	5.5	1.5	5.6	1.4	5.4	1.5	0.630	0.783
The thought of using a digital coach as a support for my training sounds: foolish vs. sensible	30	6.4	0.8	6.2	1.0	5.5	1.5	0.361	**0.007**
	29	5.2	1.5	5.5	0.9	5.3	1.4	0.278	0.741
The thought of using a digital coach as a support for my training sounds: unpleasant vs. pleasant	30	5.9	1.1	5.6	1.3	5.1	1.7	0.398	0.053
	29	4.9	1.4	5.1	1.5	5.2	1.4	0.209	0.230
The thought of using a digital coach as a support for my training sounds: uncomfortable vs. comfortable	30	6.2	0.8	5.8	1.2	4.9	1.6	0.068	**0.002**
	29	5.1	1.2	5.2	1.3	5.1	1.5	0.519	0.957

5 Discussion

This study examined the changes in self-efficacy regarding physical activity and exercising within university students who were physically inactive and who felt they needed to increase their exercise level. The main research question of the study was: Can the use of a digital coach affect self-efficacy related to physical activity and exercising within physically inactive people? The study was conducted as an intervention study which contained 59 volunteer participants divided into intervention and control group. During the 10-week intervention the intervention group participants used a sport and wellness technology digital coach. The measures used in the study were based on psychological measurement of self-efficacy that consisted of three online surveys regarding participants' perceptions about their own skills and confidence and also about their attitude towards digital coaching.

According to the results, digital coaching has some potential in affecting the self-efficacy of its users. The intervention group participants seemed more confident

at the end of the study in their abilities to overcome obstacles related to exercising as well as felt more confident in their ability to train independently without support from friends, family, or a trainer. In general, the self-efficacy towards exercising had increased, whereas the control group did not experience a significant increase in their self-efficacy.

Moreover, it also seemed that after the intervention, the intervention group participants felt more confident about their ability to analyze their own physical activity level, knowing how to improve their fitness, and on their skills to create themselves a training program. However, the results also showed that the intervention group experienced a decrease in trust towards the data they received from their digital coach. This was also apparent when measuring their attitude towards digital coaching. Control group participants did not have statistically significant changes in their attitude towards digital coaching nor in their trust towards sport and wellness technology data. Regardless of the decrease in all levels of attitude (experimental, instrumental, and overall) within the intervention group, the average attitude towards digital coaching still remained positive after the intervention in both groups.

From a theoretical perspective, the study suggests that digital coaching has potential in increasing self-efficacy related to physical activity and exercising. The results support the findings of previous studies (e.g., Kettunen et al., 2018, Feltz et al., 1988) which highlighted the role of performance-based information affecting self-efficacy positively. However, as most of the effects only occurred in the second half of the study, it indicates that it might take a while for the users to learn to train with a digital coach and to understand its potential for their own personal use and benefit. Further, it may be that 5 weeks is too short a time for significant behavioral change to occur while 10 weeks starts to be long enough for changes to be realized. Ensuring sufficient time for behavior change to occur may be an important consideration for both practitioners and researchers in future studies and physical activity interventions.

From a practical perspective, the results imply that when using digital coaches as part of interventions to promote physical activity, the length of the intervention should be long enough. And, when conducting research with such interventions, it would be good to have not just the start and end surveys but also surveys in the middle or at varied time points during the intervention period.

The finding that the trust towards the digital coach decreased during the intervention period sends a message to the developers of such solutions. They should pay increasing attention to their users' perceptions of the data and focus on improving the quality and trustworthiness of the presented data and subsequent coaching programs. And of course, base their suggestions on scientific research.

To summarize the contribution, from a theoretical perspective this study increases the understanding on how digital coaching solutions can influence physical activity related self-efficacy. From a practical standpoint, the presented practical implications can be utilized both within the sport and wellness technology industry and the society when working with digital coaching or different physical activity interventions.

6 Limitations and Future Research

The main notable limitation of this study is its relatively small sample size consisting of 59 participants divided into two sub groups. Regardless of this limitation, statistically significant differences were found in both groups. However, in the future it is worth doing a similar study with a larger group of participants. Having a large number of female participants compared to male participants could also be seen as a limitation.

As this study was combining exercise psychological perspective and digital coaching into physical activity intervention within physically inactive people, future studies could focus on using different types of digital coaches or different target groups and studying the effects within this setting.

References

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review 84 (2), 191-215.

Bandura A. (1986). Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A., (1997). Self-efficacy: The Exercise of Control. New York, NY: Freeman.

Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. Psychology and Health 13 (4), 623–649.

Chan, C. B., Ryan, D. A. a& C. Tudor-Locke (2004). Health benefits of a pedometer-based physical activity intervention in sedentary workers. Preventive Medicine. 39 (6), 1215-1222.

Cocca, A., Liukkonen, J., Mayorga-Vega, D., & Viciana-Ramírez, J. (2014). Health-related physical activity levels in Spanish youth and young adults. Perceptual and Motor Skills. 118 (1), 247-260.

Comegys, C., Hannula, M. & J. Väisänen (2006). Longitudinal comparison of Finnish and US online shopping behaviour among university students: The five-stage buying decision process. Journal of Targeting, Measurement and Analysis for Marketing 14 (4), 336-356.

Downes, L. (2015). Physical activity and dietary habits of college students. The Journal for Nurse Practitioners, 11(2), 192-198.

Faghri, P. D., Omokaro, C., Parker, C., Nichols, E., Gustavesen, S., & Blozie, E. (2008). E-technology and pedometer walking program to increase physical activity at work. The Journal of Primary Prevention. 29 (1), 73-91.

Feltz, D. (1988) "Self-confidence and sports performance." Exercise and Sport Sciences Reviews 16 (1), 423-458.

Finnish Sports Federation. (2011). Kansallinen liikuntatutkimus 2009–2010: Aikuis- ja senioriliikunta.[National Sports Study 2009-2010: Adult and Elderly Physical Activity (Report), Helsinki: Finnish Sports Federation.

Kang, M., Marshall, S. J., Barreira, T. V. & Lee, J. O. (2009). Effect of pedometer-based physical activity interventions: a meta-analysis. Research Quarterly for Exercise and sport. 80 (3), 648-655.

Kari, T., Koivunen, S., Frank, L., Makkonen, M. & Moilanen, P. (2016). Critical experiences during the implementation of a self-tracking technology. In: The proceedings of the 20th Pacific Asia Conference on Information Systems (PACIS), 27.6.-1.7.2016 (16 pages). Chiayi, Taiwan: AIS.

Kari, T., Kettunen, E., Moilanen, P. & Frank, L. (2017a.). Wellness Technology Use in Everyday Life: A Diary Study. In: The 30th Bled eConference "Digital Transformation – From Connecting Things to Transforming Our Lives, Bled, Slovenia: University of Maribor, pp. 279-294.

Kari, T., Koivunen, S., Frank, L., Makkonen, M. & Moilanen, P. (2017b). The expected and perceived well-being effects of short-term self-tracking technology use. International Journal of Networking and Virtual Organisations. 17(4), 354-370.

Kari, T., & Rinne, P. (2018). Influence of Digital Coaching on Physical Activity: Motivation and Behaviour of Physically Inactive Individuals. In Proceedings of the 31st Bled eConference "Digital Transformation – Meeting the Challenges", 17-20.6.2018 (pp. 127-145). Bled, Slovenia: University of Maribor Press.

Kettunen, E. & Kari, T. (2018). Can Sport and Wellness Technology be My Personal Trainer?: Teenagers and Digital Coaching. In: the 31th Bled eConference. Digital Transformation: Meeting the Challenges. Bled, Slovenia: University of Maribor, pp. 463-476.

Kettunen, E., Kari, T., Makkonen, M. & Critchley, W. (2018). Digital Coaching and Athlete's Self-Efficacy – A Quantitative Study on Sport and Wellness Technology. In: the Proceedings of the 12th Mediterranean Conference on Information Systems, Corfu, Greece.

Kettunen, E., Critchley, W. & Kari, T. (2019). Can Digital Coaching Boost Your Performance? – A Qualitative Study among Physically Active People. In: the

Proceedings of the 52nd Hawaii International Conference on System Sciences, Maui, USA. 14-18.1.2019.

Kranz, M., Möller, A., Hammerla, N., Diewald, S., Roalter, L., Ploetz, T. & Olivier, P. (2013). The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices. Pervasive and Mobile Computing. 9, 203-215.

Kroll, T., Kehn, M., Ho, P. S., & Groah, S. (2007). The SCI Exercise Self-Efficacy Scale (ESES): development and psychometric properties. The international journal of behavioral nutrition and physical activity, 4, (34).

Lee, E., & Kim, Y. (2019). Effect of university students' sedentary behavior on stress, anxiety, and depression. Perspectives in psychiatric care, 55(2), 164.

Liebermann, D., Katz, L., Hughes, M., Bartlett, R., McClements, J., & Franks, I. (2002). Advances in the application of information technology to sport performance. Journal of Sports Sciences. 20 (10), 755-769.

Locke, E. A. & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. American Psychologist. 57 (9), 705-717.

McAuley E. & Blissmer B. (2000). Self-efficacy determinants and consequences of physical activity. Exercise and Sport Sciences Reviews. 28, 85–88.

McAuley, E., Szabo, A., Gothe, N., & Olson, E. A. (2011). Self-efficacy: Implications for Physical Activity, Function, and Functional Limitations in Older Adults. American journal of lifestyle medicine, 5(4),

Miyamoto, S. W., Henderson, S., Young, H. M., Pande, A., & Han, J. J. (2016). Tracking health data is not enough: a qualitative exploration of the role of healthcare partnerships and mhealth technology to promote physical activity and to sustain behavior change. JMIR mHealth and uHealth. 4 (1), e5.

Schmidt, B., Benchea, S., Eichin, R. & Meurisch, C. (2015). Fitness tracker or digital personal coach: how to personalize training. In: The 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and ACM International Symposium on Wearable Computers. 7.-11.9.2017. Osaka, Japan: ACM. 1063-1067.

Shilts, M. K., Horowitz, M. & Townsend, M. S. (2004). Goal setting as a strategy for dietary and physical activity behavior change: a review of the literature. American Journal of Health Promotion. 19 (2), 81-93.

Suunto (2019). Suunto 3 Fitness. Retrieved 18.3.2019 from https://www.suunto.com/en-gb/suunto-collections/suunto-3-fitness/

Vella-Zarb, R. A., & Elgar, F. J. (2009). The 'freshman 5': a meta-analysis of weight gain in the freshman year of college. Journal of American College Health, 58(2), 161-166.

Wang, J. B., Cataldo, J. K., Ayala, G. X., Natarajan, L., Cadmus-Bertram, L. A., White, M. M., …& Pierce, J. P. (2016). Mobile and wearable device features that matter in promoting physical activity. Journal of Mobile Technology in Medicine 5 (2), 2-11.

Warraich, M. U. (2016). Wellness Routines with Wearable Activity Trackers: A Systematic Review. In: The 10th Mediterranean Conference on Information Systems (MCIS), Paphos, Cyprus.

Wilcoxon, F. (1945). Individual Comparisons by Ranking Methods. Biometrics Bulleting. 1 (6), 80-83.

Winstein, C., & Schmidt, R. (1990). Reduced Frequency of Knowledge of Results Enhances Motor Skill Learning. Journal of Experimental Psychology: Learning, Memory, and Cognition. 16, 677-691.

World Health Organization (WHO). (2017). Physical Activity. Retrieved 1.2.2019 from http://www.who.int/mediacentre/factsheets/fs385/en/

IV

USING DIGITAL COACHING TO PROMOTE PHYSICAL ACTIVITY TO UNIVERSITY STUDENTS WITH LOW LEVELS OF PHYSICAL ACTIVITY: A QUALITATIVE INTERVENTION STUDY

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Using Digital Coaching to Promote Physical Activity to University Students with Low Levels of Physical Activity: A Qualitative Intervention Study

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Abstract

Physical activity levels of university aged people have been declining in recent years. This age group is experienced in incorporating technology into their lives. Therefore, it is worthwhile to study the role sport and wellness technology could play in health promotion to this group. This exercise psychology focused intervention study explored the effects, needs and wants related to using a digital sport and wellness technology digital coach in the pursue of a more physically active lifestyle. The target group of this study was university students with low levels of physical activity. The results suggest digital coaching can motivate people with low levels of physical activity by giving them better self-awareness related to exercising. The individualized training program and feedback was perceived as positive, and digital coaching could be more effective with development towards digital coaching having more 'human' elements. These results provide information for companies and professionals working in sport and health promotion.

1. Introduction

University age students in general have been found to be at a high risk of disengagement from physical activity [1]. Insufficient physical activity is a serious health concern among this population [2]. Furthermore, according to World Health Organization (WHO) physical inactivity is a global problem having detrimental effects on health [3]. Therefore, it is important to explore new ways to help people become more physically active.

University students can be considered the "net generation" – people born after 1977 [4] – who have used different kinds of technology throughout their entire lives. With their familiarity with technology and integration of it into different parts of their lives, it is worthwhile studying whether using technology for exercise promotion purposes has potential to motivate university students toward a more physical active and healthy lifestyle.

Sport and wellness technology devices and applications have recently become more popular. Previously, these devices were prohibitively expensive, used only by the most dedicated exercisers. In the past 10-15 years the devices have become significantly less expensive and are more widely used by regular exercisers. According to previous research, receiving feedback on one's performance is considered more relevant and effective during the beginning of skill acquisition [5]. Considering this, sport and wellness technology devices and applications are also suitable for recreational exercisers with a low or intermediate knowledge level and are in the initial level of skill acquisition [6].

Even though sport and wellness technology has potential to increase the quality of physical activity and training via personalized feedback, using technology may also lead to inappropriate adjustments to training, particularly as a result of misinterpretation by the user [7]. Therefore, the information should be easy to understand and implement and importantly, matches the user's level of understanding. Providing too much information, unnecessary information, or inadequate information can create stress and anxiety for the user [8].

According to previous research, receiving feedback on how to maintain or enhance the level of physical activity and overall wellness can make users more goal oriented [e.g., 9, 10], which can lead to an increase in motivation [11, 12]. When looking at many current sport and wellness technology applications and devices, they focus only on giving feedback data from past performances instead of focusing on giving instructions and personalized suggestions on what to do next in order to get closer to personal goals.

A solution for this problem is digital coaching, a "service on a technological device that not only gives feedback but also offers advice, suggestions and future steps for a user to follow in the pursuit of their wellness

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and fitness goals" [13 pp.3]. While typical sport and wellness technology devices and applications only give feedback on performance data, a digital coach creates a personalized training plan. A digital coach can potentially identify the weaknesses and strengths of a user, and based on the collected data, create a personalized training plan and update it based on the user's actions [14]. It is important to acknowledge that digital coaching does not refer to the use of digital tools by human coaches, rather, it refers to a device or solution which in itself is the coach and functions without a human coach. The potential a digital coach has in exercise and physical activity settings has been recognized in previous IS research [15, 13, 16].

Interest in developing sport and wellness technology towards being more personalized and instructional is becoming more popular. However, digital coaching commercial solutions and devices are still relatively new in sport and exercise settings. Few studies have focused on usage experiences of digital coaching devices and applications. This study continues studying the effects of digital coaching by focusing on university students with low levels of physical activity. The study looked at the topic mostly from an exercise psychology perspective focusing on motivation and self-efficacy. Observing how using a digital coach can affect the participants' understanding and opinion about physical activity can help to understand how to create a basis for long lasting exercise motivation. The study also highlights some issues related to user experiences to understand how to further develop digital coaching.

The research questions for this qualitative study are the following: 1. How can sport and wellness technology digital coaching influence university students with low physical activity when trying to become more physically active? and 2. How would they describe their experience of using a digital coach and what are the perceptions, suggestions and wishes regarding digital coaching solutions in general? University students with low levels of physical activity were selected as a target group since they represent a demographic that are potential customers of digital coaching devices and solutions. This study contributes by increasing the theoretical and practical understanding on the usage experiences of digital coaching type of sport and wellness technology devices and applications. The study also brings insight for the developers of these types of technologies.

2. Theoretical background

The theoretical framework used in this study is the social cognitive theory by Bandura [17]. This theory is frequently used as a framework when examining motivation and physical activity. As part of social cognitive theory, Bandura introduced the concept of "self-efficacy", referring to how a person perceives their own capabilities in performing a task. People with high self-efficacy may be more likely to see a difficult task as a challenge, while those with low self-efficacy may see challenging tasks as too difficult and avoid them entirely [17]. A person's self-efficacy can be affected by a variety of information provided to them, those sources being generally categorized into four groups: previous performance accomplishments, vicarious experiences, verbal persuasion, and physiological states [17]. A person's self-efficacy is also linked to their motivation, since tasks that are considered too difficult or too easy when compared to their own perceived skill level may decrease motivation, and those which are moderately challenging yet achievable may increase motivation [18]. People with high self-efficacy may also put in more effort, be more persistent, and participate more often in physical activity [17]. Thus, self-efficacy has an important role in exercise.

Referring again to motivation, another key theory is the theory of self-determination (SDT) [19]. This theory highlights three "needs" that can affect motivation: the need for autonomy, for competence, for relatedness. Briefly, the need for autonomy relates to being able to self-regulate their behavior. The need for competence refers to being able to complete a task by effectively interacting with the surrounding environment. The need for relatedness refers to connecting with others. Each of these "needs" can, either individually or together, facilitate intrinsic motivation. Intrinsic motivation generally refers to receiving motivation and satisfaction from performing the activity itself, rather than requiring additional external stimuli or rewards. In the context of physical activity and sports, having high intrinsic motivation has been connected with forming positive exercise habits and a physically active lifestyle.

Recent research aimed to create a model for designing human-computer interaction solutions that support sustained engagement, behavior change, and wellbeing of users. Peters et al., [37] introduced the "Motivation, Engagement and Thriving in User Experience" (METUX) model, building on the self-determination theory to consider user outcomes of engagement, motivation, and thriving. The outcomes are mediated by the three factors of self-determination, which are impacted by the design of the product. The creation of a model like this shows the growing importance of the design of technological products in fostering engagement, behavior change, and wellbeing.

Another concept derived from Bandura's social cognitive theory is that of "proxy agency" [20]. Proxy agency suggests that people use "agencies" to assist in their self-development, self-renewal, and adaptation to life's demands. An "agency" refers to acts done with a

specific purpose, and Bandura defines three forms: personal, proxy, and collective. In personal agency, the person themselves acts upon the things they can personally control. Proxy agency refers to situations where a third party (an agent) will act upon the person's behalf. In collective agency a group of people pool their resources together [20, 21], as would be the case in a group project or team of athletes or exercisers.

According to Bandura [20] there are three reasons why a person would utilize proxy agency. First, a person may feel as though they do not have requisite skills or knowledge to reach their goal. Second, they may perceive that someone else is more capable of bringing them closer to their desired goal. Third, although a person may have the needed skills and knowledge, they may wish to transfer control (and responsibility) to someone else [22]. In physical activity settings, using a proxy agent, like a personal trainer, can help a person manage their task demands and assist in the regulation and control of the desired exercise behavior, and may provide instruction on learning new skills and social support. These may increase the likelihood of the person being more involved, focused, and having increased enjoyment. Proxy agency may influence an athlete's self-efficacy by providing vicarious experiences through observation,by using verbal persuasion, evaluation and feedback, setting expectations, or the use of imagery, all of which are widely used by trainers and coaches [23].

In this study, the proxy agency theory is examined from the point of view of a digital coach, where the concept of a proxy agent refers to some sort of sport and wellness technology that has a digital coaching feature. A digital coach attempts to mirror the behavior of a human proxy agent, by influencing feelings of competence by providing feedback and instructions, using a variety of persuasion techniques, in addition to other typical sports watch features.

Some research has suggested that long-term use of a proxy agent can lower the self-regulatory skills of a user, which are an important aspect in the independent management of sport and physical activity behavior [25]. However, there is limited research studying the effects of using non-human physical activity proxy agents. A digital coach, when used as a proxy agent may be a better choice than a human proxy agent in this sense, however, as a digital coach still requires a certain amount of independence and regulatory skills, while still providing some proxy agency. This may also positively affect feelings of autonomy. However, because the use of a digital coach also turns over more responsibility to a user, concerns related to the appropriate delivery and interpretation of the information become more present.

3. Methodology

3.1 The digital coach used in this study

The device used in this study was the Suunto 3 Fitness sports watch, created by Suunto OY based in Finland [26]. The device is marketed as a training watch for exercisers, and is particularly for running/walking and cycling. The Suunto 3 Fitness features "adaptive training guidance", making the watch serve as a digital coach. The device creates a 7-day training plan based on the user's fitness level and goals.

The user may also select a fitness goal, which affects the amount of recommended exercise. As a user's fitness level changes, the recommendations also change to be both challenging and achievable. The specific workout for each day is based on the user's recent training history and the remaining training load goal for the rest of the week. Background rules on the watch ensure appropriate training recommendations. For example, a hard workout is never recommended on two consecutive days.

The plan is presented on the screen, and a user can view each workout individually. On the day a user plans to exercise, the watch provides the workout goals, typically as a time measure, and an intensity description, such as "easy", "moderate", or "hard". During the workout, real-time guidance is given to ensure proper exercise intensity is achieved, using watch alarms instructing the user to speed up or slow down.

After the workout, the device provides text and numeric feedback, such as distance travelled, time spent in different heart rate zones, and estimated time needed for full recovery. Subsequent workouts may be changed based on the outcome of this workout, to avoid challenging the user too much. Alternatively, the training guidance will also adapt if a person misses a workout or decides to not do the recommended workout.

3.2 Data collection and analysis

The study followed a qualitative approach. The study included 30 participants who were given a sport and wellness technology digital coach for a 10-12 weeks period. The study was conducted in Finland during autumn and winter 2018-2019. The target group of the study was university students with low levels of physical activity but who expressed their want to increase their physical activity level. The participant recruitment was done via the student online magazine of the author's university inviting all students to take part in the study who categorized themselves being passive or currently non-regular active exercisers but who wanted to increase the level of physical activity.

Participation was on a voluntary basis as it was desired that all participants had at least an initial interest towards sport and wellness technology digital coaching. Initial interest was considered important since, like in real life, sport and wellness technology digital coaches will be bought and used only by people who are interested in the devices and solutions.

In total, 49 students expressed interest in taking part in the study. The students who, based on their personal descriptions about their current exercise habits, met the criteria of low or sedentary physical activity level were taken into the study until 30 participants were recruited. All selected participants had very low levels of current physical activity, but they were interested in finding a way to get them more motivated. The criteria for low levels of physical activity were based on the UKK Institute which is a center for health promotion research in Finland. The weekly recommendations of the UKK Institute are minimum 2h30 min moderate exercise or 1h15min vigorous exercise per week [27]. Participants did not meet these requirements. Participation was limited to 30 due to the number of available digital coach devices. All participants were provided the digital coach device by the author for the use period of the study - 10-12 weeks. In the beginning of the study the participants were given an introduction to the main functions of the digital coach and the watch itself. The users were asked to include the digital coach in their exercising and daily life in a manner that best suited them. By not giving any strict guidelines for usage the aim was to see how the participants naturally integrated a digital coach into their daily life. More detailed information about the participants can be seen in the table 1 below. The physical activity categories shown in the table derived from the Finnish National Sport survey [28] and include, ordered from the highest physical activity level to the lowest physical activity level, the following: competitive athlete, recreational sportsman, physically active for fitness, physically active for health, active in commuting and non-exercise, occasionally active, and sedentary.

Table 1. Participant information

	Male	Female	Total
N	10	20	30
Age			
< 25 years	1	7	8
25-30 years	1	7	8
31-35 years	4	2	6
36-40 years	3	2	5
> 40 years	1	2	3
Physical activity level			
Physically active for health	1	3	4
Active in commuting and non-exercise	6	10	16
Occasionally active	3	6	9
Sedentary	0	1	1
Degree under study			
Bachelor's degree	3	5	8
Master's degree	6	14	20
Doctoral degree	1	1	2
Study mode			
Full-time student	6	15	21
Part-time student	3	4	7
Other	1	1	2

The data collection was done via semi-structured interviews. A semi-structured interview does not include a complete script, but instead a pre-formed structure that the interviewer follows [29], which was created for this study. The interview script comprised of the following sections: 1. Background information, 2. Expectations for digital coaching, 3. User experiences, 4. Adaptive training guidance and real-time feedback, 5. Effects of the digital coach on exercising and 6. Ideal digital coach. For the sections 2-6 some of the questions were designed in a way to focus on the motivation and self-efficacy related issues of the topic.

All 30 participants were interviewed separately after 10-12 weeks of usage experience. In total, the average interview length was 48 minutes and varied from 36 to 69 minutes. The data analysis started by getting familiar with the data and transcribing the relevant parts of the interviews under each interview sections. The thematic analysis method was chosen for this study. This method is used for "analyzing, identifying and reporting patterns within data" [30, pp. 79] and is the most widely used analysis method in qualitative research [31]. In this research, thematic analysis enabled identifying, studying and comparing the occurring themes of the data set. Thematic analysis organizes and describes the data in rich detail interpreting various aspects and expectations related to the topic. The guidelines of Braun and Clarke [30] were followed during the analysis phase. These guidelines were applied in a flexible manner to fit the research questions and data. In the analysis process, a recursive process, rather than a linear phase-to-phase process was used, allowing moving back and forth between the analysis phases and reaching a deeper understanding

and more detailed analysis of the entire research data. In the analysis the focus was on one interview section at a time. Each person's answers were written in an Excel file which enabled searching for reoccurring themes, similarities and differences between participants related to the same topic. The most highlighted themes of each section are reported in this paper.

4. Results and findings

4.1 User experiences

In general, the participants felt the digital coach was easy to learn to use. The only problem some users faced in the beginning of the test period was related to synchronizing their phone with the application which then would provide them with their baseline fitness level used in creation of the personalized training program. 23 of the 30 participants reported using the digital coach for the entire study period and the remaining 7 participants started using the device but then quit using it entirely after 1-2 months. The reasons for stopping was usually due to wearing the watch did not feel comfortable or the participants no longer found the device useful for them. However, some participants said they stopped using the device because they had already learned a lot and felt they did not need it anymore. Half of the participants reported having worn the digital coach also during night time, which provided them information also about their sleep. The other half used it only during the daytime.

The digital coach had several different features described before. The most preferred and utilized features of the digital coach were the adaptive training guidance, training diary and step counter. Almost as popular features were sleep measurement, stress and recovery measurement as well as heart rate measurement. Participants appreciated the digital coach having a wide variety of sports where to choose from and this inspired couple of participants to even try new types of exercising. The digital coach also kept participants up to date on their current stress and energy levels. Most of the participants paid attention to their stress level score but only a few participants ever modified their daily life based on their stress score. Nevertheless, paying attention to their stress score made some participants think about the reasons behind the score and what might cause them stress: "I learned to recognize what kind of situations can lower my stress level and how those situations change my feeling at the time". Many participants reported that they did not necessarily believe that they were stressed even though the digital coach said so. One of the reasons for this disbelief was the lack of understanding on what the stress score is based on. Most of the participants also appreciated the fact that the digital coach could also been used as a basic watch that not only shows time and date but can also be synchronized with messages and emails if wanted. However, none of the participants wanted to share their training results on social media even though the application had easy options for doing so. The reason for not sharing was usually that participants felt exercising and exercise data is person and they did not want to be compared to other people.

Participants were also asked about what they felt the positive and negative issues were related to the digital coach. Participants felt that the digital coach was easy to use and offered a large amount of data which helped participants understand more about their own exercising. Having visible data made them more aware about their exercising and encouraged them to be more physically active. As one participant said: "It is a convenient way to follow your own progress and see that little effort actually does already makes a difference when it comes to improving my fitness". Participants also liked the notifications received, such as when they achieved a daily step goal. In general, a positive thing was that the digital coach was able to increase the knowledge and understanding of the participants related to training and recovery.

Besides the positive experiences, participants also had negative experiences and suggestions on improving the digital coach. Some participants felt the digital coach should give more notifications when the user had missed a workout or had an otherwise less physically active period. Some participants felt that the device gave too much information, causing them more stress. Still, most participants would have liked to have more explanatory information supporting the result and suggestions the digital coach offered them. In other words, they felt the current level of communication was not always enough or sometimes not clear enough for the user to be able to learn from it. Another issue that was highlighted by many participants was the lack of trust in accuracy of the wrist heart rate measurement, which affected the usage experience of other features such as stress data, sleep data and adaptive training guidance.

4.2 Adaptive training guidance and feedback

In the beginning of the usage period the digital coach planned a personalized training plan for each participant. The plan was based on the personalized information received from the user as well as on their fitness test results. The first impressions about the program were fairly unanimous: the program seemed easy and not too demanding. However, based on the feelings associated with the first impression, the participants split into two. For the first half the easy start was seen as positive and encouraging. Since the trainings were relatively short in the beginning, for this

group, it created a feeling that the goals are achievable. For half of the other participants, the easy start produced negative feelings. Having only a relatively short training session made these people doubt the effectiveness and usefulness of the training plan which lead to demotivation towards following the scheduled program. As one participant said: "*I started laughing when I received instructions for trainings that lasted for 20min. When I used to actively train, my session lasted like 2 hours.*" The skepticism of the effectiveness of the program occurred especially with participants who had an exercise background despite being currently not being very physically active. However, some of these participants said that even though it does not feel natural for them, having a slow start would be smarter when starting to exercise after a break and therefore they understood the reasoning behind the program.

Participants were instructed to follow the adaptive training guidance the way that best suited them. All participants said they had become familiar with the training plan and tried it. However, 10 participants stopped using the training plan after the first try. 13 participants reported following the training plan but eight of them quit following it approximately after the half way of the study, whereas five participants reported using the adaptive training guidance throughout the entire study. The remaining participants used the training guidance occasionally. Most participants using the adaptive training guidance wished that they could have modified the training plan to better fit their everyday life. This modification usually meant switching training and rest days. One reason why some participants did not use the adaptive training guidance was that they wanted more personalization: *"In order for me to be willing to give more control to the device in guiding my training, the digital coach would have needed to be even more personalized"*. However, some participants saw the adaptiveness of the program as a positive feature and were delighted that someone is planning their exercising for them.

A feature related to the adaptive training guidance was the real-time feedback. Eight participants reported not using the feature in their training sessions while the rest did. Reasons for not using the real-time feedback feature was usually mistrust of the heart rate measurement accuracy or a preference to follow one's own feeling rather than instructions related to pace and intensity. Most participants who included real-time feedback in their training session felt that the feature was helpful. The participants reported often changing their intensity based on the digital coach's instructions.

Overall, regardless of the level of usage, participants felt they gained something from using the adaptive training guidance as well as real time feedback. Participants felt the extra information they received not only helped them to train at the proper intensity level, but also that varying their intensity, such as through interval training, is also beneficial. Some participants said they learned to feel in their body what the right intensity level feels like: *"I learned to recognize how I feel when my heart rate is at a particular level and because of this I can also train without sport technology in the future"*. 27 of 30 participants expressed at the end of the study their interest to use either adaptive training guidance, real-time feedback or both in the future.

4.3 Effects on physical activity

When participants were asked whether their physical activity had changed in some way during the test period, 22 participants reported having experienced a change. Most of them reported a slight increase in the daily activity due to the increase in every day active commuting. For some participants this meant switching driving or biking to walking whereas some participants increased the amount of walking in general. Some participants also reported being more consistent with their exercise and having had more variety on their physical activity. A few participants had started a new hobby as a result of being in the study. Four participants reported having better physical fitness after the study period whereas one participant said their physical condition had gone backwards during the study.

24 of the participants said using the digital coach had had a positive effect on their exercise motivation whereas only one person reported having negative effects. Seeing one's own exercise data and getting feedback on performance were the key issued that seemed to increase the level of motivation. Receiving personalized data and instructions seemed to make participants more aware of their own physical activity and health and the increased knowledge lead to positive motivation. As one participant said: "*The digital coach helped me to channel my exercise motivation that I already had in me. Training became more consistent and since I started training at lower intensities my training motivation lasted longer.*"

However, in general participants highlighted that a digital coach cannot be the only source of exercise motivation. But, if a user has at least a small level of personal motivation, a digital coach can be a useful tool to help move exercising to the right direction. Participants could see digital coaching fitting many types of users from beginners to athletes. However, it would be most suitable for people who are interested in technology, receiving exercise data, and using that to reaching their physical activity goal. Most participants also recommended a digital coach for beginner exercisers who do not have information on how to start exercising and who do not have time, interest or courage

to necessarily join group exercise or hire a personal trainer. Participants saw a digital coach having mostly positive effects on users but some highlighted that technology should not be the central focus while exercising so that it does not create stress.

Participants were also asked whether using the digital coach had any influence on their exercise self-efficacy. 9 participants reported having some positive effects on their exercise self-efficacy, often due to the performance data, increased knowledge and positive feedback. One participant felt an increase in self-efficacy because they realized they did not necessarily need any outside help but were capable of being in charge of their own exercising. None of the participants reported having any negative effects on their exercise self-efficacy. Some participants also reported that using digital coaching impacted their lives outside of exercising. They reported feeling more energetic during the day, which resulted from exercising more or going to bed earlier and gaining more sleep.

At the end of the study participants were asked whether they will change their physical activity habits in any way in the future due to the usage of the digital coach. 26 of the 30 participants said they have made changes to their exercising routines and will continue the new routine also in the future: *"Since I noticed how bad shape I am in, I started making little changes towards a more active lifestyle, such as walking home from school."* In most cases the reason for this change was the good feeling participants had received from exercising, suggesting the motivation had become more intrinsic. Some participants had bought their own sport and wellness technology device, some participants had booked a health check with their doctor and one participant had hired a personal trainer. Most participants said they will continue tracking their exercising also in the future in one way or another.

4.4 The ideal digital coach

At the end of the usage period the participants were asked to describe what their ideal digital coach would be like and how it would function. One third of the participants suggested their ideal digital coach would be a combination of a watch and mobile phone application. The next equally popular options were a watch and a mobile phone application as separate units. Some participants wanted their digital coach to be less visible such as a bracelet or a necklace. Some participants also would like to include a heart rate belt into their ideal digital coach to guarantee a more accurate heart rate measurement. The participants were also asked what type of information their ideal digital coach would provide them. The answers varied between participants but the most common features were related to overall training data and features like training intensity, training plan, or heart rate. Also, sleep and recovery related information was considered important as well as step and calorie counting. Food and nutrition related to training or weight loss was also considered essential. Other less common suggestions were that the ideal digital coach could have exercise route options, body temperature measurement, information on meditation and relaxation or psychological wellbeing, a weather forecast, drinking water consumption data. Some participants also wanted their ideal digital coach to include advice also on gym training and would be able to analyze whether the user can perform all the movements in a correct and safe way. The theme that was common is that the digital coaches should be able to adjust based on the users' personal needs and wants and that after purchasing a digital coach person should be able to modify the digital coach to include the essential features and if necessary, delete features they are not interested in. A digital coach should be easy to use and also have some human elements: *"Manufacturers could make digital coaches more human like and less like a machine that encourages people to constantly complete tasks like a robot".*

Participants reported that they preferably like to receive information from their ideal digital coach via text. Less common suggestions were voice, graphics, videos and numerical data. While training the ideal way of communicating with the digital coach would be sound and vibration since they were considered least disturbing. Some participants also suggested their ideal digital coach would have voice control, which would enable easy communication with the coach especially during the training. Participants also describe what kind of personality their ideal digital coach would have. Most participants wanted to have a positive and supportive and at the same time realistic digital coach who would remind them when they should exercise again. The feeling that the digital coach actually pays attention and is interested about the user was also highlighted.

Participants were also asked whether they would prefer, in the future, a digital coach or a personal human coach as their trainer. 22 participants chose a human coach whereas 7 participants chose digital coach. One participant would choose neither. The reasons for choosing a digital coach were the lower cost and the freedom to use the coach at their convenience. Another reason for choosing a digital coach was feeling less pressure as there was no other person involved to judge or make demands, making this option feel easier and less scary for some participants. One participant also highlighted that: *"By having a digital coach you do work for yourself and not for someone else. And when you succeed you can be proud of yourself and take the full honor and responsibility".*

Reasons for selecting a personal human coach were related to the overall human interaction and the ability to communicate and be heard. A human coach could also see the person as a whole and make adjustments and corrections when needed. The participants appreciated the fact that they would be able to ask and get extra information from a human coach related to different topics and also talk about issues that do not necessarily relate to training. Participants described that the bond with a human coach compared to a digital coach would be tighter and they would be less likely to skip trainings as they feel they owe something to someone. However, most participants stated that if it were possible, they would prefer having both coaches, because the combination would support one another. The human coach could get information from the digital coach as well as help the user to use the digital coach more efficiently. On the other hand, during the times between meeting with a human coach, the digital coach would monitor and keep the user up to date on the progress.

5. Discussion

The purpose of this study was to explore the effects, needs and wants related to using a sport and wellness technology digital coach in the pursuit of a more physically active lifestyle. The target group was university students with low levels of physical activity.

The study examined the topic from an exercise psychology perspective focusing on motivation and self-efficacy but also focusing on issues related to user experiences. The research questions were: 1. How can sport and wellness technology digital coaching influence university students with low levels of physical activity when trying to become more physically active? and 2. How would they describe their experience of using a digital coach and what are the perceptions, suggestions and wishes regarding digital coaching solutions in general?

The findings indicate that university students with low levels of physical activity do find sport and wellness technology digital coaching interesting in general and feel a digital coach may help them become more physically active. Digital coaching can provide a large amount of personalized data, which might have otherwise been unavailable, and was found useful and motivating. This finding supports previous research findings [32, 33]. However, user's background knowledge is an important consideration. An expert exerciser may appreciate raw data, novice users need data that is easy to understand and act upon. Users also desire to increase their knowledge level of their own physical activity and health and would have liked to get even more information from the digital coach on topics they were interested in. With the specific device in this study, the topics participants followed the most were the adaptive training coach, training diary and step counter.

The real-time feedback from the device was perceived positively, helping users to find optimal exercise intensity and bring some variation into training. The adaptive training guidance feature that builds upon the real-time feedback was viewed as interesting, but participants tended to stop using the feature after some time. The adaptive training coach offered relatively easy recommendations at first, which has been shown by research to decrease barriers to starting and increases motivation. Conversely, some participants disliked how initially easy it was, which increased mistrust in the guidance and decreased motivation to use it.

In general, digital coaching was seen to have potential for people with low levels of physical activity and who are interested in technology and data. However, a digital coach by itself may not be able to motivate users to exercise.

From a theoretical perspective, the results show that digital coaching can affect users' exercise motivation by making training more goal oriented and also by increasing the overall knowledge with personalized data. Increased knowledge can increase self-efficacy. Having a relatively easy start in the personalized training plan can also increase self-efficacy by goals that seem achievable. These results support the results of a previous study [34] which highlighted that increased self-efficacy related to the users' confidence in their abilities to overcome obstacles related to exercising and their ability to train independently without support from friends, family or a trainer.

From the point of view of self-determination theory, the feeling of competence is the most important factor affecting the motivation of people with low levels of physical activity. The feeling of relatedness was also highlighted since participants liked communicating with the digital coach and appreciated that they were being provided support for their exercise, such as by having workouts planned for them. The importance of relatedness was seen in negative experiences, as noted above where the watch gave too easy workouts. For a digital coach to feel "personalized", users need to actually feel the device identifies their needs correctly. Comparatively, another digital coach study [9] done among athletes there showed a difference. Whereas less active people seem to appreciate the feeling of competence and relatedness provided by the digital coach, more physically active people highlighted the increase in the feeling of autonomy as the main motivational factor related to digital coaching.

Our results also seem to parallel the ideas in the METUX model. The user outcomes - engagement, motivation, and thriving – are intertwined. This was seen, for example, when participants lost motivation as

a result of feeling less engaged in easy training. One outcome seems to lead to further outcomes.

However, a digital coach as a proxy agent is not necessarily yet as effective or appreciated as a human coach for people with low physical activity levels. Digital coaches still lack a human element that seems to be very important for this target group. Based on the results of this study, digital coaching has potential to teach people how to take control of their own exercising by educating them on their own health. The results also suggest that participants were interested in having a digital coach to increase their own skills and knowledge and to get instruction on how to improve their skills. These findings go together with Bandura's [20] findings related to reasons for using proxy agency. In a previous study [25], having a human proxy agent was seen to lower self-regulatory and task self-efficacy.

Conversely, this study showed that a digital coach may enhance self-regulatory skills and task self-efficacy. Some participants felt they had learned enough from the digital coach and no longer needed a proxy agent at all. However, with the majority of participants still stating they would still choose a human coach over a digital one, there are still qualities a human coach possess that digital coaches have not yet reproduced.

As a practical contribution the study presents implications for future development for digital coaches. Firstly, it seemed that the wrist-based heart rate measurement is not yet accurate enough, which can cause lack in motivation to use the device in the first place. Therefore, it would be important to offer another type of heart rate measurement option along the optical heart rate measurement. It is also important to further personalize the instructional feedback and training guidance to give the users the feeling the digital coach is looking after them. The users should also be offered a possibility to study more about a certain interesting topic which could be done for example via application or computer. Different users are generally interested in different features and therefore the users could be given a possibility to personalize their own digital coach by choosing how it looks and what information it has. These suggestions support the results of Yardley et al. [35] that highlighted the importance of a person-based approach, especially in digital interventions. Also, increasing motivational and supportive messaging could be a way to increase the motivation to continue using the digital coach, especially in the user group of people who are only starting to become more physically active.

Based on the findings the needs and wants related to digital coaching differ for different people. However, the role of educational, supportive and motivational messaging seems to play an important role in this target group irrespective of said needs and wants. Usability issues are also important. Although a digital coach was seen as a relatively inexpensive option, the participants in this target group still preferred a human coach over a digital one. However, based on the results it can be seen that there is an interest in using a combination of digital and personal human coach.

6. Limitations and future research

There are a few limitations in the study. Firstly, a less than three-month long study period is relatively short, although the period was long enough for participants to experience how a digital coach can affect their physical activity. Secondly, the average age of university students in Finland can be higher compared to other countries [36] and therefore the participants in this study represented a wide age range. This might make the comparison with studies done in other countries less direct. Thirdly, the results of this study are based on the usage experiences from one particular digital coach device. The results could vary depending on the device/application used in the study. This study is among the first to focus on the user experiences of digital coaching among people with low physical activity. The topic of sport and wellness technology digital coaching continues to be important. Future studies could focus on exploring the topic with different types of digital coaching devices or among different target groups, such as elderly people or teenagers. It could also be interesting to study the possible negative effects of digital coaching on users especially from an exercise psychology point of view.

7. References

[1] A. Cocca, J. Liukkonen, D. Mayorga-Vega, and J. Viciana-Ramírez, "Health-related Physical Activity Levels in Spanish Youth and Young Adults", Perceptual and Motor Skills, 118 (1), 2014, pp. 247-260.

[2] J. D. Irwin, "Prevalence of University Students' Sufficient Physical Activity: A Systematic Review", Perceptual and Motor Skills, 98(3), 2004, pp. 927–943.

[3] World Health Organization (WHO), "Global Strategy on Diet, Physical Activity and Health." 2020, URL: https://www.who.int/dietphysicalactivity/factsheet_inactivity/en/ (visited on 14/07/2020).

[4] C. Comegys, M. Hannula, and J. Väisänen, "Longitudinal Comparison of Finnish and US Online Shopping Behaviour among University Students: The Five-stage Buying Decision Process", Journal of Targeting, Measurement and Analysis for Marketing, 1(4), 2006, pp. 336-356.

[5] C. Winstein, and R. Schmidt, "Reduced Frequency of Knowledge of Results Enhances Motor Skill Learning", Journal of Experimental Psychology: Learning, Memory, and Cognition, 16, 1990, pp. 677-691.

[6] D. Liebermann, L. Katz, M. Hughes, R. Bartlett, J. McClements and I. Franks, "Advances in the Application

of Information Technology to Sport Performance", Journal of Sports Sciences, 20(10), 2002, pp. 755-769.
[7] P. Düking, A. Hotho, H-C. Holmberg, F. Fuss and B. Sperlich, "Comparison of Non-invasive Individual Monitoring of the Training and Health of Athletes with Commercially Available Wearable Technologies." Frontiers in Physiology, 7 (71), 2016, pp. 1-11.
[8] S. Halson, J. Peake, and J. Sullivan, "Wearable Technology for Athletes: Information Over-load and Pseudoscience?,", International Journal of Sports Physiology and Performance 11 (6), 2016, pp. 705–706.
[9] T. Kari, S. Koivunen, L. Frank, Makkonen, P. and P. Moilanen. "Critical experiences during the implementation of a self-tracking technology." The proceedings of the 20th PACIS Conference, Chiayi, Taiwan, 2016.
[10] T. Kari, S. Koivunen, L. Frank, M. Makkonen, and P. Moilanen, "The Expected and Perceived Wellbeing Effects of Short-term Self-tracking Technology Use", International Journal of Networking and Virtual Organisations 17(4), 2017, pp. 354-370.
[11] E.A. Locke, and G. P. Latham, "Building a Practically Useful Theory of Goal Setting and Task Motivation: A 35-year odyssey", American Psychologist, 57(9), 2002, pp. 705-717.
[12] M. K. Shilts, M. Horowitz and M.S. Townsend, "Goal Setting as a Strategy for Dietary and Physical Activity Behavior Change: a Review of the Literature", American Journal of Health Promotion, 19(2), 2004, pp. 81-93.
[13] E. Kettunen and T Kari. "Can Sport and Wellness Technology be My Personal Trainer? – Teenagers and Digital Coaching", Proceedings of the 30th Bled eConference, Bled, Slovenia, 2018, pp. 463-476.
[14] B. Schmidt, S. Benchea, R. Eichin and C. Meurisch, "Fitness Tracker or Digital Personal Coach: How to Personalize Training." Proceedings of the ACM International Joint Conference on Pervasive and Ubiquitous Computing and ACM International Symposium on Wearable Computers, Osaka, Japan: ACM, 2015, pp. 1063-1067.
[15] M. Kranz, A. Möller, N. Hammerla, S. Diewald, L. Roalter, T. Ploetz and P. Olivier, "The Mobile Fitness Coach: Towards Individualized Skill Assessment Using Personalized Mobile Devices" Pervasive and Mobile Computing 9, 2013, pp. 203-215.
[16] E. Kettunen, C. Critchley and T. Kari. "Can Digital Coaching Boost Your Performance? – A Qualitative Study among Physically Active People." Proceedings of the 52nd Hawaii International Conference on System Sciences, Maui, USA, 2019.
[17] Bandura, A., Social Foundations of Thought and Action: A Social Cognitive Theory, Englewood Cliffs, NJ: Prentice-Hall, 1986.
[18] A. Bandura, "Health promotion from the Perspective of Social Cognitive Theory", Psychology and Health, 13(4), 1998, pp. 623–649.
[19] R.M. Ryan and E.L. Deci, "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions", Contemporary Educational Psychology, 25(1), 2000, pp. 54-67.
[20] A. Bandura, "Self-efficacy Mechanism in Human Agency", American Psychologist, 37, 1982, pp. 122-147.
[21] Beauchamp, M. R. and M. A. Eys, Group Dynamics in Exercise and Sport Psychology – Contemporary Themes, New York, NY: Routledge, 2007.
[22] Bandura, A., Self-efficacy: The Exercise of Control. New York, NY: Freeman, 1997.
[23] D. Feltz and C. Lirgg, "Self-efficacy Beliefs of Athletes, Team, and Coaches" In R. Singer, H. Hausenblas and C. Janelle (Eds.) Handbook of Sport Psychology, 2nd ed., New York: John Wiley & Sons, 2001, pp. 340-361.
[25] C. Shields, and L. Brawley, "Preferring Proxy-agency: Impact on Self-efficacy for Exercise", Journal of Health Psychology, 11(6), 2006, pp. 904-914.
[26] Suunto, 2020, URL:https://www.suunto.com/en-gb/Products/sports-watches/suunto-3-fitness/suunto-3-fitness-all-black/ (visited on 14.7.2020)
[27] UKK Institute, "Physical Activity Pie", 2020, URL: https://www.ukkinstituutti.fi/en/products-services/physical_activity_pie (visited on 11/07/2020)
[28] Finnish Sports Federation, Kansallinen Liikuntatutkimus 2009-2010: Aikuis- ja senioriliikunta. [National Sports Survey 2009-2010] Report, Finnish Sports Federation, Helsinki, Finland, 2011.
[29] M. Myers, and M. Newman, "The Qualitative Interview In IS Research: Examining The Craft." Information and Organization, 17(1), 2017, pp. 2–26.
[30] V. Braun, and V. Clarke, "Using Thematic Analysis in Psychology", Qualitative Research in Psychology, 3(2), 2006, pp. 77–101.
[31] Guest, G., K.M. MacQueen and E.E. Namey, Applied Thematic Analysis. Los Angeles, CA: SAGE, 2012.
[32] T. Kari, E. Kettunen, P. Moilanen and L. Frank, "Wellness Technology Use in Everyday Life: A Diary Study", Proceedings of the 30th Bled eConference: Bled, Slovenia, University of Maribor, 2017a, pp. 279-294.
[33] J.B. Wang, J.K. Cataldo, G.X. Ayala, L. Natarajan, L.A. Cadmus-Bertram, M.M. White…and J.P. Pierce, "Mobile and Wearable Device Features that Matter in Promoting Physical Activity", Journal of Mobile Technology in Medicine, 5(2), 2016, pp. 2-11.
[34] E. Kettunen, T. Kari, M. Makkonen, W. Critchley and A. Sell, "Digital Coaching among Physically Inactive University Students: A Quantitative Intervention Study on Exercise Self-efficacy." Proceedings of the 32th Bled eConference: Bled, Slovenia, University of Maribor, University of Maribor, 2019, pp. 861-880.
[35] L. Yardley, L. Morrison, K. Bradbury and I. Muller, "The Person-Based Approach to Intervention Development: Application to Digital Health-Related Behavior Change Interventions", Journal of Medical Internet Research, 17(1), 2015, pp. e30.
[36] Finnish National Agency for Education, 2017, URL: https://www.oph.fi/fi/uutiset/2017/oecd-vertailu-suomalaiset-suorittavat-opintonsa-loppuun-mutta-keskimaaraista
[37] D. Peters, R.A. Calvo, and R.M. Ryan, "Designing for Motivation, Engagement and Wellbeing in Digital Experience." Frontiers in Psychology, 9(797), pp. 1-15

V

YOUNG ELDERLY AND DIGITAL COACHING: A QUANTITATIVE INTERVENTION STUDY ON EXERCISE SELF-EFFICACY

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YOUNG ELDERLY AND DIGITAL COACHING: A QUANTITATIVE INTERVENTION STUDY ON EXERCISE SELF-EFFICACY

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Abstract Sport and wellness technology devices are becoming an increasingly relevant topic when discussing health and wellness. This study focuses on the use of a "digital coach", within a specific population, young elderly people. This research explored how the use of a digital coach would affect self-efficacy related to physical activity and exercise among young elderly. This quantitative intervention study provided a digital coaching device to a group of young elderly people ranging from 61-78 in age for 10-weeks. It was found that a digital coach may be useful for this population, particularly in increasing their perceived confidence in exercising independently. However, the participants' perceptions of the device were more negative after the intervention period, although the overall perception was still positive. These results provide insight for sport technology companies and people who work with the young elderly on the possibilities of digital coaching and its usage for health promotion.

Keywords: digital wellness, physical activity, digital coach, self-efficacy, young elderly, sport and wellness technology, intervention.

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1 Introduction

Use of Sport and wellness technologies has become increasingly popular. There is a wide variety of devices, applications, and services aimed for different target groups and for different needs. Indeed, they are used by various types of users and for various purposes (Kettunen et al., 2017; Moilanen et al., 2014). These technologies can potentially offer many benefits to their users. For example, they can be used to promote physical activity (PA) (e.g., de Vries et al., 2016; Romeo et al., 2019), to support goal-setting (e.g., Gordon et al., 2019), and to increase the awareness of personal PA (e.g., Kari et al., 2017a; Wang et al., 2016). However, these benefits may not maintain the use of sport and wellness technologies (Kari et al., 2017a; Miyamoto et al., 2016), which in turn can lead to reduction in PA levels (Attig & Franke, 2020). A common issue with sport and wellness technologies is that they mainly provide feedback through numbers or charts instead of instructional information. Providing personalized achievable goals, sufficient guidance, and easy to understand information might promote use adherence and help in maintaining PA and exercise routines. Further, feedback on how to promote exercise can make use of the devices more goal-oriented (e.g., Kari et al. 2017b), which can lead to increased motivation (Shilts et al., 2004). Hence, providing the users with actual guidance and personalized workout plans would increase the possibility of making both the use of the technology and the exercise routines more goal-oriented.

One potential solution for this is digital coaching, which refers to a "service on a technological device that not only gives feedback but also offers advice, suggestions and future steps for a user to follow in the pursuit of their wellness and fitness goals" (Kettunen & Kari, 2018, p.3). The potential of digital coaching regarding PA and exercise has been recognized. However, some limitations have also been raised (e.g., Kranz et al., 2013; Kari & Rinne, 2018; Kettunen & Kari, 2018; Kettunen et al., 2018; 2019a; Helmefalk et al., 2020). Thus, it is important to continue studying digital coaching solutions and their use. This study investigates the usage of digital coaches from an exercise psychology perspective. Specifically, the aim is to find out how the use of a sport and wellness technology digital coach affects exercise self-efficacy of the young elderly (i.e., age 60–75). The focus was on self-efficacy, due to its significant relationship with PA performance affecting the choice of activity, effort, persistence, and vulnerability to stress (Bandura, 1997). The main research question

of the study is: "Does the use of a digital coach affect self-efficacy related to PA and exercising within young elderly?"

Young elderly were chosen as the target group as it is imperative to find ways to help them lead a more physically active life before they become elderly. The share of elderly people is increasing: persons aged 65 years or older cover 18–22% of the population in most EU countries (Eurostat, 2019). In addition, the life expectancy at older ages is increasing globally (United Nations, 2019). PA has been shown to be a key component for a healthier life at older age (Hoogendijk et al., 2019) and finding ways to support it is essential.

2 Theoretical Background

This study's theoretical background is based on Bandura's (1977) theory of self-efficacy. Self-efficacy relates to a person's beliefs in their own capability to perform a specific task. If a person has high self-efficacy, they are likely to view difficult tasks as a challenge and an opportunity, while a person with low self-efficacy may tend to avoid difficult tasks. Self-efficacy may also affect motivation, as it impacts the amount of effort a person is willing to put in to overcome a specific task.

The sources of information that affect self-efficacy have been categorized into four aspects: performance accomplishment, vicarious experience, verbal persuasion, and physiological states (Bandura, 1998). Several of these aspects also closely relate to Bandura's social cognitive theory (1986) which suggested that a person's actions are influenced by their observations of the world around them and the actions of others. Social cognitive theory highlights how social experience and observational learning in development of personality is used as a framework when studying motivation and PA.

In this study, the theoretical background of self-efficacy could be said to take the form of "exercise self-efficacy", as the focus is primarily on PA and exercise. Self-efficacy has been shown to have high influence in adopting PA habits (McAuley & Blissmer, 2000), hence why it was chosen for this particular study. It has also shown to be even more important when PA has not become a habit (Bandura, 1986). Self-efficacy has been associated with maintaining long-term PA (McAuley et al., 2011), and hence people with high self-efficacy may participate in PA more frequently and work harder (Bandura, 1986). Self-efficacy is a widely used theory in studying self-

confidence and motivation in sport performance studies, and one of the most researched concepts in the fields of PA (Kroll et al., 2007) and sport performance (Feltz, 1988), which is a key reason for its focus in this study.

Another part of the theoretical framework, proxy agency theory, comes also from the work of Bandura. The proxy agency refers to a situation where a third-party acts as an agent on a person's behalf (Bandura, 1982; Beauchamp & Eys, 2007). There are three reasons for people to use a proxy agent. Firstly, people might feel they do not have the skills or knowledge to reach their desired outcome. Secondly, even though they would possess those skills they may think that having a proxy agent might lead to better results. Thirdly, using a proxy agent relates to the desire to hand over the responsibility and control to someone else (Bandura, 1997). In PA and exercise settings a proxy agent can refer, for example, to a coach or a personal trainer. In this particular study, the proxy agency theory is studied from the point of view of digital coaching, referring to a sport and wellness technology device consisting of digital coaching features. The interest is whether a digital proxy agent is also able to affect the feelings of competence and confidence by providing instructions, feedback, and persuasion as well as providing performance accomplishments similar to what a human proxy agent can.

3 Methodology

3.1 The Digital Coach Used in the Study

The device used in this study was the Suunto 3 Fitness (Suunto, 2019). The Suunto 3 Fitness is a fitness watch for monitoring daily PA, stress, recovery, and sleep, primarily through the device's wrist-based heart rate sensor. The watch can also be linked to a smartphone app which provides additional feedback and may also collect movement data by using the phone's GPS. One particular feature of the Suunto 3 Fitness is "adaptive training guidance" (i.e., a digital coach). The feature creates a customized training plan directly on the watch based on the user's background and training history. The training guidance provides several days of future workouts with specific details of the duration and intensity of each workout. If the user follows the recommended workout, it will also guide the user through the workout to ensure the session is performed at the correct intensity. This is done by monitoring the user's heart rate and providing real-time feedback through notifications on the screen, via the watch's vibration, or by audio. The guidance instructs the user to increase or

decrease the exercise intensity, most obviously by speeding up or slowing down. The training plan adapts after each workout based on the user's performance during that workout. If the workout is too hard or too easy, the plan may decrease or increase the intensity of future workouts. Criteria are built into the digital coach's algorithms to ensure that the training plan is also physiologically appropriate, such as by not planning two hard workouts in a row or by following well-known periodization methods when creating the training plan.

3.2 Data collection and analysis

The target population of this study was young elderly. The study was conducted as an intervention study and comprised an intervention group and a control group. The participants were recruited from a Finnish University of the 3rd Age (UTA), which offers weekly scientific sessions and a meeting spot for elderly people. The participants were recruited via a short presentation during a weekly UTA lecture, which resulted in recruitment of 80% of the participants. The rest were recruited via snowball method. All who volunteered for the study and were in the target age group were selected as participants. In total, 62 people volunteered for the study.

The participants were randomly divided into two sub-groups. The intervention group had 30 participants and the control group had 32 participants. The reason for limiting the number of participants in the intervention group to 30 was due to the number of available digital coach devices. Even though the division of participants into two groups was done randomly, the aim was to make the groups homogenous in terms of the number of men and women in each group. Participants' level of PA did not influence the sample selection nor the grouping. The 10-week-long intervention period started in June 2019. During the period, participants in the intervention group used the digital coach and participants in the control group continued their exercising without a digital coach. Participants in the intervention group were asked to use the device in the way that best suited them in order to make the user experience as convenient and pleasant as possible.

The data was collected via three online surveys. The first survey was sent to all the participants before the intervention group were given the digital coaches. The second survey was sent after 5 weeks and the third survey at the end of the 10-week intervention. The measurements were conducted identically for both groups in all three surveys: First, the questionnaire included an exercise self-efficacy scale by Kroll et al. (2007), consisting of 10 items on a four-point scale ranging from one (not at

all true) to four (exactly true). Second, there were 13 items concerning the self-efficacy of exercising and improving fitness in general as well as the role of sport and wellness technology in exercising. These statements were presented on a seven-point Likert scale ranging from one (strongly disagree) to seven (strongly agree). These items were not, as such, intended as measures of specific constructs related to self-efficacy, although some of the items shared common themes. Thus, the responses were examined at the item level instead of the construct level. Third, the questionnaire contained five items measuring the attitude towards using a digital coach as a support for training by using a seven-point semantic differential scale ranging from -3 to +3, which was rescaled for the analysis to range from 1 to 7. A lower score suggested a more negative attitude, whereas a higher score suggested a more positive attitude. In all parts of the questionnaire, the order of the items was randomized for each participant. Responding to the items was non-mandatory, meaning that missing values in the data were possible.

Participants' age ranged from 61 to 78 years. Information on the participants' PA background was collected using a categorization based on the Finnish National Sport Survey (Finnish Sports Federation, 2011), which classifies people into seven categories based on their PA level. The categories, in order from the most to least active, were: competition athletes, fitness athletes, fitness participants, physically active for health, active in commuting and non-exercise, occasionally active, and inactive or sedentary. This was enquired retrospectively after the study was finished. None of the intervention group participants had previous experience with a digital coach. However, 60% had at least tested a heart rate monitor or an activity bracelet before, 30% had used a PA application, and 20% had used a pedometer. 37% of the intervention participants had no previous experience with sport and wellness technology. Table 1 displays the descriptive statistics of the participants.

Table 1: Descriptive statistics of the participants and the two sub-groups.

	Whole sample (N = 62)		Intervention group (N = 30)		Control group (N = 32)	
	N	**%**	**N**	**%**	**N**	**%**
Gender						
Male	22	35.5	10	33.3	12	37.5
Female	40	64.5	20	66.7	20	62.5
Age						
61–65 years	17	27.4	7	23.3	10	31.3
66–70 years	26	41.9	15	50.0	11	34.4
71–75 years	16	25.8	7	23.3	9	28.1
76–80 years	3	4.8	1	3.3	2	6.3
Socioeconomic status						
Working	4	6.5	2	6.7	2	6.3
Retired	57	91.9	28	93.3	29	90.6
Other	1	1.6	0	0.0	1	3.1
PA background						
Fitness athletes	4	6.5	2	6.7	2	6.3
Fitness participants	22	35.5	11	36.7	11	34.4
Physically active for health	25	40.3	11	36.7	14	43.8
Active in commuting and non-exercise	9	14.5	4	13.3	5	15.6
Occasionally active	1	1.6	1	3.3	0	0.0
Sedentary	1	1.6	1	3.3	0	0.0

The data was analyzed using the IBM SPSS Statistics 24 software. The Wilcoxon (1945) signed-rank test was used because of the small sample size and the non-normal distributions of some of the items. A statistical significance threshold of $p < 0.05$ was used. If a participant did not answer a particular item in all three surveys, all responses from that participant of that particular item were excluded. Thus, the exact number of respondents (N) may vary slightly between the items.

4 Results

The results are reported in three sub-sections. The first sub-section concentrates on overall self-efficacy. The second sub-section focuses on self-efficacy specifically related to perceptions of sport and wellness technology as it pertains to training and improvement of PA. The third sub-section relates to attitude towards using a digital coach. From left to right, the columns of the tables report the number of respondents (N), the mean and standard deviations of the measures at the three time-points, and the p-values. The p-values are from the Wilcoxon signed-rank tests, and the first p-value is for the test comparing the statistical significance of the change in means between the first and second time-point, whereas the second p-value is for the test comparing the statistical significance of the change in means between the first and third time-point.

4.1 Exercise Self-efficacy

The scale used for measuring exercise self-efficacy (Kroll et al., 2007) included 10 statements regarding personal abilities related to PA (Table 2). The results show almost no statistically significant changes in exercise self-efficacy in either groups. The only time-point and statement where there was a statistically significant change was at the end of the intervention, where the intervention group felt more confident in their abilities to start exercising again after having stopped exercising for a while. The control group did not show any statistically significant changes.

Table 2: Changes in exercise self-efficacy (grey rows: intervention group, white rows: control group, scale: from 1 = "not at all true" to 4 = "exactly true").

Statement	N	Time 1		Time 2		Time 3		p (1 vs. 2)	p (1 vs. 3)
		Mean	SD	Mean	SD	Mean	SD		
I can overcome barriers and challenges with regard to PA and exercise if I try hard enough	28	3.4	0.6	3.3	0.7	3.3	0.6	0.593	0.157
	31	3.5	0.7	3.4	0.8	3.3	0.6	0.331	0.058
I can find means and ways to be physically active and exercise	28	3.4	0.6	3.4	0.7	3.6	0.6	1.000	0.059
	31	3.5	0.8	3.5	0.8	3.5	0.7	0.837	0.951
I can accomplish my PA and exercise goals that I set	28	3.0	0.7	3.1	0.7	3.2	0.8	0.439	0.132
	31	3.1	0.8	3.1	0.7	3.1	0.5	1.000	0.755
When I am confronted with a barrier to PA or exercise, I can find several solutions to overcome this barrier	26	3.0	0.8	3.2	0.7	3.3	0.7	0.096	0.117
	31	3.1	0.7	3.0	0.9	3.0	0.7	0.712	0.627
I can be physically active or exercise even when I am tired	26	2.6	0.8	2.6	0.9	2.8	0.8	0.675	0.160
	32	2.8	0.8	2.7	0.8	2.8	0.9	0.371	1.000
I can be physically active or exercise even when I am feeling depressed	21	3.1	0.7	3.1	0.5	3.1	0.7	1.000	0.782
	30	3.0	0.8	3.0	0.8	2.7	0.8	1.000	0.063
I can be physically active or exercise even without the support of my family or friends	28	3.5	0.6	3.6	0.7	3.6	0.6	0.454	0.480
	30	3.5	0.8	3.7	0.7	3.5	0.7	0.166	0.851
I can be physically active or exercise without the help of a therapist or trainer	26	3.5	0.8	3.7	0.5	3.7	0.5	0.161	0.197
	30	3.4	0.8	3.4	0.9	3.4	0.8	0.822	0.927
I can motivate myself to start being physically active or exercising again after I've stopped	27	3.2	0.7	3.4	0.6	3.6	0.5	0.052	**0.013**
	31	3.5	0.8	3.4	0.7	3.4	0.7	0.637	0.596
I can be physically active or exercise even if I had no access to a gym, exercise, or rehabilitation facility	28	3.6	0.7	3.6	0.6	3.5	0.6	1.000	0.763
	30	3.4	0.9	3.5	0.8	3.5	0.8	0.357	0.683

4.2 Self-efficacy Related to Exercising and Improving Fitness, and the Role of Sport and Wellness Technology

The self-efficacy related to the participants' overall opinions about their exercising and improving their own fitness was measured by a total of 13 statements, out of which six were related to the role of sport and wellness technology (Table 3).

Both the intervention and the control group were more confident at the end of the intervention that they do not necessarily need help in creating themselves a suitable training program. The intervention group also felt more confident to train without any kind of guidance or coaching at the end of the intervention. The intervention group also felt more and more strongly as the intervention went along that it was less hard for them to find out how to improve their fitness. The other statistically significant changes related to the intervention group losing some of their confidence on the truthfulness, accuracy, and reliability regarding the information given by sport and wellness technology. These changes appeared already at the midpoint of the intervention.

Table 3: Changes in self-efficacy related to improving fitness and sport and wellness technology (grey rows: intervention group, white rows: control group, scale: from 1 = "strongly disagree" to 7 = "strongly agree").

Statement	N	Time 1		Time 2		Time 3		p (1 vs. 2)	p (1 vs. 3)
		Mean	SD	Mean	SD	Mean	SD		
I know how to create myself an exercising program	29	4.0	1.8	4.4	1.6	4.5	1.6	0.082	0.093
	30	4.2	1.2	4.3	1.2	4.6	1.1	0.551	0.146
I know how to create myself an exercising program	29	4.0	1.8	4.4	1.6	4.5	1.6	0.082	0.093
	30	4.2	1.2	4.3	1.2	4.6	1.1	0.551	0.146
I need help in creating myself a suitable exercising program	30	4.8	1.5	3.8	1.8	3.4	1.8	**0.011**	**0.001**
	32	4.5	1.6	4.6	1.7	3.8	1.7	0.638	**0.004**
I am able to train independently without any guidance or coaching	30	5.1	1.5	5.2	1.5	5.8	1.3	0.440	**0.010**
	32	5.4	1.4	5.3	1.4	5.4	1.3	0.827	0.853
Sport and wellness technology has an important role in my exercising	27	3.6	1.8	3.8	1.5	3.7	1.4	0.487	0.683
	30	3.4	1.7	3.4	1.6	3.3	1.4	0.746	0.736

Sport and wellness technology provides me with important information that I can use in my exercising	30	5.7	1.2	5.0	1.4	5.1	1.2	0.052	0.051
	30	4.9	1.5	4.9	1.7	4.5	1.7	0.933	0.113
I am able to improve my fitness with the help of sport and wellness technology	30	5.3	1.4	4.7	1.6	4.8	1.7	0.076	0.116
	29	4.8	1.4	4.8	1.5	4.4	1.5	0.977	0.102
I believe that sport and wellness technology provides me with reliable information regarding my own exercising	30	5.9	1.0	5.0	1.4	4.7	1.3	**0.011**	**0.001**
	29	5.3	1.6	5.5	1.4	5.0	1.5	0.369	0.128
I believe that sport and wellness technology provides me with accurate information regarding my own exercising	29	5.4	1.2	4.8	1.2	4.7	1.5	**0.036**	**0.020**
	29	5.4	1.4	5.4	1.5	5.2	1.3	0.971	0.231
I believe that sport and wellness technology provides me with truthful information regarding my own exercising	30	5.6	1.0	4.9	1.3	4.8	1.5	**0.038**	0.054
	31	5.4	1.4	5.4	1.5	5.2	1.3	0.805	0.299
It is hard for me to find out how to improve my aerobic fitness	29	3.6	1.8	2.8	1.7	2.6	1.5	**0.036**	**0.019**
	30	3.5	1.9	3.3	1.7	3.3	1.7	0.838	0.569
I do not know how to increase the level of my aerobic fitness	30	2.8	1.6	2.3	1.5	2.4	1.7	0.147	0.186
	29	3.2	2.0	3.1	1.9	2.8	1.5	0.695	0.290
It is hard for me to analyze my aerobic fitness	30	4.1	1.6	4.0	1.5	3.5	1.7	0.681	0.053
	30	4.3	1.9	4.2	1.8	3.9	1.6	0.300	0.225
I know how to improve my aerobic fitness	30	5.3	1.4	5.2	1.3	5.7	0.9	0.697	0.071
	31	4.8	1.4	4.9	1.1	4.7	1.5	0.882	0.747

4.3 Attitude towards using a digital coach

The attitude towards using a digital coach was measured by five statements focusing on the following three aspects of attitudinal evaluations: the overall attitude (bad vs. good), the experimental aspect (unpleasant vs. pleasant and uncomfortable vs. comfortable), and the instrumental aspect (useless vs. useful and foolish vs. sensible) (Table 4). It is noticeable that both the intervention group and the control group

experienced a decline in their attitude towards digital coaching. For most of the statements, a statistically significant decline appeared already at the midpoint of the intervention. However, regarding comfortableness, a statistically significant decline appeared only at the end of the intervention. Despite the decline, the attitude of both the groups towards digital coaching still remained as relatively positive at the end of the intervention.

Table 4: Changes in attitude towards using a digital coach (grey rows: intervention group, white rows: control group, scale: from 1 to 7).

Statement	N	Time 1		Time 2		Time 3		p (1 vs. 2)	p (1 vs. 3)
		Mean	SD	Mean	SD	Mean	SD		
The thought of using a digital coach as a support for my training sounds: **bad (1) vs. good (7)**	30	5.8	1.3	5.5	1.1	5.3	1.3	0.090	0.082
	32	5.6	1.2	5.2	1.4	5.3	1.3	**0.042**	0.058
The thought of using a digital coach as a support for my training sounds: **useless (1) vs. useful (7)**	30	6.0	1.1	5.5	1.4	5.4	1.3	**0.006**	**0.003**
	32	5.6	1.6	5.3	1.4	5.2	1.5	0.084	0.139
The thought of using a digital coach as a support for my training sounds: **foolish (1) vs. sensible (7)**	30	5.8	1.4	5.5	1.4	5.4	1.1	0.187	0.223
	32	5.8	1.2	5.2	1.6	5.1	1.5	**0.007**	**0.004**
The thought of using a digital coach as a support for my training sounds: **unpleasant (1) vs. pleasant (7)**	30	5.7	1.4	5.2	1.3	5.3	1.2	**0.047**	0.115
	32	5.4	1.4	5.2	1.2	4.9	1.4	0.264	**0.012**
The thought of using a digital coach as a support for my training sounds: **uncomfortable (1) vs. comfortable (7)**	30	5.8	1.3	5.5	1.2	5.2	1.3	0.136	**0.017**
	32	5.6	1.2	5.2	1.4	5.0	1.3	0.054	**0.016**

5 Discussion

This study focused on the target group of young elderly and examined the changes in self-efficacy regarding PA and exercising. The main research question was: "Does the use of a digital coach affect self-efficacy related to PA and exercising within young elderly?" The study contained 62 participants divided into an intervention group and a control group and was conducted as a 10-week intervention study. The participants in the intervention group used a sport and wellness technology digital coach during the intervention. The data was collected via three online surveys containing items related to exercise self-efficacy, attitude towards using a digital coach, as well as self-efficacy of exercising and improving fitness in general, and the role of sport and wellness technology in exercise.

The 10-week intervention produced the following results: related to exercise self-efficacy, only one item showed a statistically significant change as the members of the intervention group felt more confident that they could restart exercising after having stopped exercising for a while. As to the self-efficacy related to exercising and improving fitness and to the role of sport and wellness technology in exercising, more statistically significant changes could be identified. The perceived need for help for an exercising program was reduced significantly in both the groups. In addition, the intervention group felt more confident to be able to train independently, and it was less hard for them to find out how to improve their fitness. From a theoretical perspective, this result could be seen as an enhancement of the participants' feeling of autonomy.

However, the perceived reliability, accuracy, and truthfulness of sport and wellness technology were significantly reduced among the participants of the intervention group. Thus, the users of the digital coach device (i.e., the intervention group) had a more positive perception of sport and wellness technology in general before the intervention than after it. This might be a result of initial expectations being too high regarding the exactness of the device used in the study, as the use of it during the intervention might have shown inexact results. Still, the perceptions of sport and wellness technology remained on a relatively high and positive level and, although statistically significant, no dramatic changes (from positive to negative) in attitude occurred. However, as the intervention group felt more confident towards independent exercising after the intervention, it can be reasoned that the use of the digital coach had a positive effect on confidence in this part.

Attitudes towards using a digital coach were found to decline in several respects and in both groups of the study. The control group found the use of a digital coach to be a less pleasant, less sensible, and less comfortable idea after the study period. One potential explanation for this is that the members of the control group might have been able to increase their exercising and exercise motivation without a digital coach, and, as a result, see less use for digital coaching than before the study period. The intervention group found the use of a digital coach as less useful and less comfortable after the intervention. This may reflect that the usefulness and comfortableness of digital coaching device were expected to be higher in advance, but these expectations were not fulfilled by the digital coach used in the intervention. However, the attitudes still remained at a relatively positive level. These results are similar to the results of a previous study (Kettunen et al., 2019b) done with a physically less active and younger target group. Overall, based on these quantitative results alone, it is difficult to say what caused the decline in both groups' attitude.

To conclude, as a proxy agent, digital coaching may be a useful approach to support PA and exercise among young elderly, particularly in increasing their perceived confidence in exercising independently. A digital coach can have potential in making young elderly people more aware of how they should improve their fitness. However, certain limitations need to be noted, and more research is needed on the topic.

6 Limitations and Future Research

The results of this study are limited to the selected age group of young elderly and to the selected technology. The participant groups might also have an 'activity' bias as the participants are active participants of the society. The statistically significant declines found in the perceived reliability of sport and wellness technology as well as in the attitude towards using a digital coach call for further research, for example, providing qualitative insights on the topic. It would also be interesting to investigate these effects by using other kinds of digital coaching solutions with different features or different feedback modalities.

References

Attig, C., Franke, T. (2020). Abandonment of personal quantification: a review and empirical study investigating reasons for wearable activity tracking attrition. Computers in Human Behavior, 102, 223-237.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review 84 (2), 191-215.

Bandura, A. (1982). "Self-efficacy mechanism in human agency." American Psychology 37, 122-147.

Bandura A. (1986). Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A., (1997). Self-efficacy: The Exercise of Control. New York, NY: Freeman.

Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. Psychology and Health 13 (4), 623–649.

de Vries, H. J., Kooiman, T. J., van Ittersum, M. W., van Brussel, M., de Groot, M. (2016). Do activity monitors increase physical activity in adults with overweight or obesity? A systematic review and meta-analysis. Obesity, 24, 2078-2091.

Eurostat. (2019). Population structure and ageing. https://ec.europa.eu/eurostat/statistics-explained/index.php/Population_structure_and_ageing, last accessed 7.3.2020.

Feltz, D. (1988) "Self-confidence and sports performance." Exercise and Sport Sciences Reviews 16 (1), 423-458.

Finnish Sports Federation. (2011). Kansallinen liikuntatutkimus 2009–2010: Aikuis- ja senioriliikunta. [National Sports Study 2009-2010: Adult and Elderly Physical Activity (Report), Helsinki: Finnish Sports Federation.

Gordon, M., Althoff, T., Leskovec, J. (2019). Goal-setting and achievement in activity tracking apps: a case study of MyFitnessPal. In Proceedings of the World Wide Web Conference, pp. 571-582. ACM, New York, NY.

Helmefalk, M., Marcusson, L., & Sell, A. (2020). "Who cares about fireworks?"–A Study on Digital Coaching, Gamification and Exercise Motivation. In Proceedings of the 53rd Hawaii International Conference on System Sciences.

Hoogendijk, E. O., Afilalo, J., Ensrud, K. E., Kowal, P., Onder, G., Fried, L. P. (2019). Frailty: implications for clinical practice and public health. The Lancet, 394, 1365-1375.

Kari, T., Kettunen, E., Moilanen, P. & Frank, L. (2017a). Wellness Technology Use in Everyday Life: A Diary Study. In Proceedings of the 30th Bled eConference. Bled, Slovenia: University of Maribor, pp. 279-294.

Kari, T., Koivunen, S., Frank, L., Makkonen, M. & Moilanen, P. (2017b). The expected and perceived well-being effects of short-term self-tracking technology use. International Journal of Networking and Virtual Organisations, 17(4), 354-370.

Kari, T., & Rinne, P. (2018). Influence of Digital Coaching on Physical Activity: Motivation and Behaviour of Physically Inactive Individuals. In Proceedings of the 31st Bled eConference, 17-20.6.2018 (pp. 127-145). Bled, Slovenia: University of Maribor Press.

Kettunen, E., Critchley, W. & Kari, T. (2019a). Can Digital Coaching Boost Your Performance? – A Qualitative Study among Physically Active People. In Proceedings of the 52nd Hawaii International Conference on System Sciences, Maui, USA. 14-18.1.2019.

Kettunen, E. & Kari, T. (2018). Can Sport and Wellness Technology be My Personal Trainer? Teenagers and Digital Coaching. In Proceedings of the 31st Bled eConference, 17-20.6.2018 (pp. 463-476). Bled, Slovenia: University of Maribor Press.

Kettunen, E., Kari, T., Makkonen, M. & Critchley, W. (2018). Digital Coaching and Athlete's Self-Efficacy – A Quantitative Study on Sport and Wellness Technology. In Proceedings of the 12th Mediterranean Conference on Information Systems, Corfu, Greece.

Kettunen, E., Kari, T., Makkonen, M., Critchley, W., & Sell, A. (2019b). Digital Coaching among University Students with Low Levels of Physical Activity: A Quantitative Intervention Study on Exercise Self-efficacy. In Proceedings of the 32nd Bled eConference, 16-19.6.2019 (pp. 861-880). Bled, Slovenia: University of Maribor Press.

Kettunen, E., Kari, T., Moilanen, P., Vehmas, H., Frank, L. (2017). Ideal types of sport and wellness technology users. In Proceedings of the 11th Mediterranean Conference on Information Systems, 12 pages. AIS, Genoa, Italy.

Kranz, M., Möller, A., Hammerla, N., Diewald, S., Roalter, L., Ploetz, T. & Olivier, P. (2013). The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices. Pervasive and Mobile Computing, 9, 203-215.

Kroll, T., Kehn, M., Ho, P. S., & Groah, S. (2007). The SCI Exercise Self-Efficacy Scale (ESES): development and psychometric properties. The international journal of behavioral nutrition and physical activity, 4, (34).

McAuley E. & Blissmer B. (2000). Self-efficacy determinants and consequences of physical activity. Exercise and Sport Sciences Reviews, 28, 85–88.

McAuley, E., Szabo, A., Gothe, N., & Olson, E. A. (2011). Self-efficacy: Implications for Physical Activity, Function, and Functional Limitations in Older Adults. American journal of lifestyle medicine, 5(4),

Miyamoto, S. W., Henderson, S., Young, H. M., Pande, A., & Han, J. J. (2016). Tracking health data is not enough. JMIR mHealth and uHealth, 1, e5.

Moilanen, P., Salo, M., & Frank, L. (2014). Inhibitors, enablers and social side winds Explaining the use of exercise tracking systems. In proceedings of the 27th Bled eConference, 1-5.6.2014 (pp. 23-37). Bled, Slovenia: University of Maribor Press.

Romeo, A., Edney, S., Plotnikoff, R., Curtis, R., Ryan, J., Sanders, I., ... Maher, C. (2019). Can smartphone apps increase physical activity? systematic review and meta-analysis. Journal of Medical Internet Research, 21, e12053.

Shilts, M. K., Horowitz, M. & Townsend, M. S. (2004). Goal setting as a strategy for dietary and physical activity behavior change: a review of the literature. American Journal of Health Promotion, 19, 81-93.

Suunto (2019). Suunto 3 Fitness. https://www.suunto.com/en-gb/suunto-collections/suunto-3-fitness/, last accessed 18.3.2020.

Wang, J. B., Cataldo, J. K., Ayala, G. X., Natarajan, L., Cadmus-Bertram, L. A., White, M. M., …& Pierce, J. P. (2016). Mobile and wearable device features that matter in promoting physical activity. Journal of Mobile Technology in Medicine, 5, 2-11.

Wilcoxon, F. (1945). Individual Comparisons by Ranking Methods. Biometrics Bulleting. 1 (6), 80-83.

United Nations. (2019). World population ageing 2019. https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Highlights.pdf.

VI

DIGITAL COACHING MOTIVATING YOUNG ELDERLY PEOPLE TOWARDS PHYSICAL ACTIVITY

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Article

Digital Coaching Motivating Young Elderly People towards Physical Activity

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Abstract: The share of the elderly population is increasing globally, and it is important to help them to maintain their physical activity levels and ability to function to as late an age as possible. This qualitative intervention study focused on the experiences of young elderly on the ability of a sport and wellness technology digital coach to motivate them towards physical activity as well as on what needs and wishes this group has concerning digital coaching solutions. The findings of the study show that young elderly perceive digital coaching as potential in motivating them towards physical activity by providing instructive information and motivational feedback. It was also perceived to have positive influence on their exercise self-efficacy. However, it was also apparent that digital coaching devices should be tailored for this target group and be easy to learn in order to attract interest among them. Our findings provide insights for professionals and companies in sport technology field as well as to health professionals working in health promotion with young elderly people. Overall, this research aims to address social and economical sustainability of elderly people and their physical activity.

Keywords: digital coaching; exercise psychology; motivation; self-efficacy; sport technology; young elderly

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1. Introduction and Previous Research

The proportion of elderly people and the healthy life expectancy at older ages is increasing globally [1,2]. For example, in EU countries already more than 20% of the population is aged over 65 years [3]. Globally, the number of people aged over 65 years is projected to double by 2050 [1]. Unsurprisingly, this raises the importance of finding ways to effectively support a healthy aging population. One essential factor in healthy aging is physical activity (PA). For example, regular PA has significant health benefits and contributes to the prevention of non-communicable diseases [2]. One of United Nations' goals for sustainable development is ensuring healthy lives and promoting well-being for all at all ages [4].

PA has been shown to be a vital factor in keeping older people independent and mobile by helping to improve and maintain physical and mental functions [5]. Moreover, PA also aids in maintaining the ability to function when a person gets older and is essential to ward off frailty and age-related illness [6]. Considering the essential role of physical activity in healthy aging [5,6], it is imperative to find suitable solutions that can support and encourage elderly people to be more physically active, make exercising more enjoyable, and help them feel more confident about participating in PA in general. In our research, we aim to find out how using sport and wellness technology, and especially digital coaching, can affect young elderly people's exercise motivation and explore how they perceive the use and influence of digital coach solutions.

In recent years, the use of sport and wellness technology has become more popular as the variety of applications and devices has increased. Currently, sport and wellness technology devices are targeted to many different types of users from athletes to beginners and

from young people to elderly users. This type of technology can provide its users several benefits, such as increased PA levels e.g., [7–9], increased awareness related to personal PA e.g., [10,11] and support in goal-setting e.g., [12], among many others. However, it should also be noted that sometimes users encounter negative and harmful experiences with such technologies [13]. One central issue is that many sport and wellness technology devices provide mostly numerical information rather than instructional information. Receiving clear information on how to increase PA and exercise can make the use of sport and wellness technology more goal-oriented e.g., [14], which in turn, can lead to increased motivation [15]. Thus, providing more instructional and personal feedback could make PA and the use of sport and wellness technology more goal-oriented and subsequently lead to increased motivation towards it.

One of the latest developments related to sport and wellness technology is a digital coaching feature. This refers to a "service on a technological device that not only gives feedback but also offers advice, suggestions and future steps for a user to follow in the pursuit of their wellness and fitness goals" [16] p. 3. Advantageously, a digital coaching feature can provide personalized feedback based on the user's own data and give specific adaptive instructions on daily basis. In this study a digital coach does not refer to a sport and wellness technology device or application that merely tracks activity or allows manual programming of training. In the case of digital coaching the device itself creates and updates the personalized plan without human interference. As the general interest towards sport and wellness technology digital coaching solutions has increased, so has academic interest in the topic, and the research on the use of digital coaching solutions, also referred to as eCoaching e.g., [17] or virtual coaching e.g., [18], has been on the rise. Digital coaching has been recognized as potential in PA promotion, but has also been acknowledged to have limitations, particularly in being able to adequately adapt to individual differences in the user's values, goals, and behaviors that a human coach would otherwise easily be able to do e.g., [16,19–23]. This research aims to find ways how to better adapt to these individual needs and differences.

Moreover, research on the use experiences of older user populations with such solutions is scarce, despite being a user group with distinct needs and challenges [24]. Hence, it is important to advance the research on this topic.

Sport and wellness technology have been found promising in terms of promoting PA among older populations. However, questions have been posed regarding their effectiveness. In studies focusing on older populations, Ref. [25] found that mobile solutions can promote PA and PA self-efficacy. Ref. [26] found eHealth interventions to be effective in promoting PA at least on a short-term scale. Likewise, Ref. [27] found mobile health application-based interventions to have potential in promoting PA on short term. Ref. [8] found low-quality evidence for physical activity monitor-based interventions to promote PA. Ref. [28] found that digitally deployed behavior change interventions could increase PA and the ability to function. From these studies, it is apparent that more advanced solutions are needed.

Digital coaching has been recognized as having potential for PA promotion across different age groups. For example, Kettunen and Kari (2018) found that among teenagers, digital coaching is generally perceived as interesting and able to provide needed instructions concerning PA. They also found that it positively influenced the users' PA behavior [16]. Ref. [16] found a mobile application with a digital coaching feature to support PA motivation and PA behavior among physically inactive young adults. In addition, they found that the use also influenced other aspects of physical wellness as the users began to pay more attention to their wellness behavior between the instructed PA sessions [20]. Ref. [29] found digital coaching solutions had potential in increasing PA of inactive older adults. These studies indicate that sport and wellness technology digital coaches can promote PA among different age groups. However, it seems that certain design considerations need to be taken into account for digital coaching solutions to be successful.

In a scoping review, Ref. [30] identified key components of persuasive digital coaching and self-tracking which have the potential to positively influence both health behavior and technology use: personalization of goals, reduction (setting short-term goals to eventually reach long-term goals), reminders to input data, use of validity-tested devices, praise messages, and the integration of self-tracking and persuasive digital coaching. Ref. [31] further highlight the significance of goal-setting functionalities and PA programs. Ref. [32] found that digital coaching solutions could increase PA adherence by utilizing high quality prompts, motivators, and feedback, and by personalizing and simplifying the user experience. However, they also note that the design challenges go beyond the information technology domain, as developing a successful persuasive digital coaching solution requires co-design and co-creation with the users, as well as the implementation of behavior change techniques and persuasive strategies that are appropriate for the target population [32].

While these studies provide important insights on sport and wellness technology digital coaches and their use, it seems to us that only a few (e.g., [29]) have investigated their use among older populations. Overall, more research on sport and wellness technology digital coaches is warranted.

To address the aforementioned research gap, this study continues the investigation of digital coaching in the PA setting and among the specific segment of young elderly [24], which consists of people aged approximately 60–75 years. The target group for the study was selected in order to find ways to help them lead a more physically active life at older age. As mentioned above, the main aim of this qualitative intervention study was to find out how using a sport and wellness technology digital coach can affect young elderly people's exercise motivation and explore how they perceive the use and influence of such solutions in their pursuit of reaching or maintaining a physically active lifestyle. The study's theoretical background is based on exercise psychology theories, more precisely, on self-determination theory by [33,34] social cognitive theory, focusing on two important aspects of them: self-efficacy and proxy agency.

The research questions the present study seeks to answer are the following: First, how does sport and wellness technology digital coaching influence motivation to exercise, particularly related to feelings of autonomy, competence, relatedness, and self-efficacy in young elderly people for maintaining and achieving a more physically active lifestyle? Second, how do young elderly users describe their experiences of using a digital coach? This topic encompasses the experiences this population had while using a sport and wellness technology digital coach, their perceptions on the central feature, the adaptive training guidance of a digital coach, and their opinions on a digital coach's ability to support PA and fitness, including ideas on the kind of digital coach device that would be ideal for young elderly users.

By answering these research questions, this study contributes to the research streams on digital coaching, technology and behavior, and information systems (IS) use by increasing the theoretical and practical understanding of usage experiences with digital coaching sport and wellness technology solutions among the young elderly. Moreover, insights on how a digital coach influences perceptions and understanding of PA can increase knowledge on ways to foster long lasting PA motivation and sustained PA behaviors. The study also offers practical insights for companies designing and developing sport and wellness technologies on how to create products that meet the needs and wants of the older user populations. On a larger scale this study aims to find ways to better support possibilities of elderly people to stay physically active and give them a possibility to use modern technology. Ultimately, this is related to supporting sustainable development from a social and an economic perspective.

2. Theoretical Background

The study's theoretical background is based on exercise psychology, more precisely, on Bandura's (1986) social cognitive theory and two important aspects of it: self-efficacy and proxy agency. It also focuses on Deci & Ryan's theory of Self-determination (2000).

2.1. Self-Determination Theory

The second important theory, which relates more specifically to motivation, is Deci & Ryan's theory of self-determination (SDT) [33]. Self-determination theory is a well-known theory in psychology that focuses on three "needs" that affect motivation: the needs for competence, autonomy, and relatedness. Each of these needs can, individually, or in combination with each other, facilitate motivation. SDT makes an important distinction in the types of motivation, distinguishing between extrinsic and intrinsic motivation, both of which have different determinants and outcomes on a person's behavior. Generally, people who possess intrinsic motivation to do a task, particularly in the area of exercise, will find the activity more fun and enjoyable over the long-term than someone who is extrinsically motivated [35].

Intrinsic motivation is characterized by having satisfaction come from achieving of a task itself, rather than from an additional reward or stimuli. High intrinsic motivation is usually connected with being more engaged in a task over the long-term and is particularly influential in the field of sports and exercise, as a high level of intrinsic motivation has been shown to improve positive exercise habits and active lifestyle outcomes.

As mentioned, self-determination theory uses the three "needs", which drive human behavior and serve as the building blocks for creating intrinsic motivation. Briefly, the need for autonomy relates to an individual's ability to manage and organize their own behavior. Coaches who are controlling towards their athletes, for example, may not encourage satisfaction of this need. The need for competence relates to a person experiencing some feelings of being effective and confident in what they are doing. Not only does this need relate to a person's actual skills, but also to social factors, such as verbal encouragement from peers or coaches. Finally, the need for relatedness is also a social need, relating to desiring a sense of connectedness and belonging with others with similar goals or values.

Given that extrinsic motivation necessarily requires some sort of external reward to sustain motivation, it is unsurprising that most physical activity interventions and devices, such as digital coaches, would be most focused on improving the intrinsic motivation of an exerciser. There are many things that can have both a short- and a long-term effect on a person's motivation to exercise extrinsically and intrinsically. In this study the focus was not on the participants' levels of intrinsic and extrinsic motivations and the possible changes in motivation. Rather, since studying a person's motivation is such a broad concept, in this research the focus was narrowed to study only the potential effects that a digital coach has on the feelings of competence, autonomy and relatedness. Instead of focusing on the ways motivation is affected by the digital coach, it is important to study and develop knowledge of the fundamental building blocks of intrinsic motivation in Self-Determination Theory—the needs for competence, autonomy, and relatedness.

2.2. Self-Efficacy

Social cognitive theory is frequently used as a framework for studying PA and motivation, particularly in the context of the concept of self-efficacy. Self-efficacy refers to how a person perceives their own capability to perform a certain task, where persons with high self-efficacy look at difficult tasks as an opportunity or a challenge, and persons with low self-efficacy may see those same challenges as too difficult and try to avoid them [34]. Self-efficacy can be affected by information a person receives, which is generally categorized into four groups: previous accomplishments, verbal persuasion, physiological states, and vicarious experiences [34]. As a result of a person's self-efficacy and the way they view tasks, their motivation to attempt the task can also be affected. A task that seems challenging but achievable will have a positive effect on motivation and the opposite effect is seen when tasks seem impossible [36].

Self-efficacy's significance in positive exercise behavior has been consistently shown in previous research. Ref. [37] found that exercise self-efficacy was a significant contributor to the maintenance of exercise behavior in middle-aged adults. Self-efficacy was also found to have a strong correlation to subjective measures of performance, demonstrating that

self-efficacy affects a person's perception of how successful they were in performing the task at hand [38] A positive execution of a healthy activity, for example, would increase a person's perception of their capability to perform it again next time, thus increasing self-efficacy and healthy exercise behaviors. Self-efficacy has also been shown to have a significant effect on adherence to exercise in both the adoption and early maintenance phase, which span the first year of a person changing a health behavior [39]. While there may be many factors that influence health behaviors, self-efficacy is one component that clearly has a significant influence.

2.3. Proxy Agency

The human-computer interaction to facilitate improvements in a person's well-being was also theorized within Bandura's social cognitive theory, with the term "proxy agency" [40]. Agency refers to a person's ability to influence the world around them through their actions. By extension, therefore, proxy agency is where the person uses a third party to act on their behalf. Bandura suggested three typical reasons why a person would utilize a proxy agency [40]. A person might use a proxy agent when they feel the task exceeds their perceived skill or knowledge level. They also may use a proxy agent if they have identified someone else who is capable of bringing themselves closer to their goal than they might have achieved alone. Finally, in situations when people actually have the required skills or knowledge, they may wish to transfer control or responsibility to someone else, in which case they may use a proxy agent. Proxy agents are common in sports and exercise, the most obvious example being a coach or a personal trainer. Someone who helps a person manage the task demands required to achieve a desired exercise behavior, and can also provide instruction, feedback, or social support, all of which are, as mentioned, factors that may affect a person's self-efficacy. Any number of other common behaviors exercisers use can serve as proxy agencies, such as observing other athletes to provide vicarious experiences, verbal persuasion from other teammates or exercisers, or sport psychology skills such as goal setting or imagery [41].

In this study, the theory of proxy agency is applied through the use of a sport and wellness technology device that has a digital coaching feature. The digital coaching feature aims to, in some form, replicate the role of a human coach, by providing a training plan tailored to the user's goals, specific feedback on their fitness and performance, as well as encouragement and persuasion to continue exercise, and also by adjusting recommendations based on the progress of the user.

As a counter-point to the previously discussed purported benefits of proxy agents, some research has also suggested that use of a proxy agent lowers the self-regulatory skills of a user, effectively making them less capable of managing their behavior independently [42]. However, this research has generally been focused on the use of human proxy agents, and there is limited research studying the effects of a non-human PA proxy agent. A digital coach, serving as a proxy agent in this context, may prove to be more effective than a human proxy agent because it still requires at least a certain amount of independence to utilize effectively. This may also have a positive impact on a person's feelings of autonomy, although it will also transfer some of the responsibility of personal management over to the user, which can be a limiting factor for new exercisers with lower self-efficacy. This makes it essential that a digital coach be effective in its delivery of information to enable a user to feel capable of understanding and acting upon the digital coach's instructions.

3. Methodology

Methodologically, this study follows a qualitative approach. A qualitative approach was selected because the aim was not to measure the possible changes in the participants' behavior but rather to increase the understanding of the multiple ways a digital coach can affect physical activity and wellbeing. The qualitative approach also enables richer descriptions and explanations of the users' experiences [43].

3.1. The Digital Coach Used in the Study

The device used for this study was the Suunto 3 Fitness sports watch, made by the Finnish company Suunto Oy based in [44]. The Suunto 3 is marketed as a training watch, focused on the fitness market, primarily for running/walking or cycling. The device includes a wrist-based heart rate monitor, 24/7 activity tracking, sleep monitoring, stress and recovery reports, and all of the typical fitness watch features, such as a timer and GPS tracking when paired with a smartphone.

One particular feature promoted for this device is "personalized adaptive training guidance", a feature that takes into account the user's physiological information, training history, and personal fitness goals to recommend a training schedule and daily workouts. When first using the device, the user may select a training goal they would like to achieve, and the device will recommend workouts to achieve said goal. As the user's fitness changes, the workouts will adjust to be sufficiently challenging without becoming too difficult. Each specific daily workout is based on the user's fitness level and their recent training history, ensuring appropriate training recommendations. If a user decides not to follow the recommended daily workout, the device will automatically adjust the training recommendations to allow the user to still achieve their fitness goals in consideration of their day-to-day lifestyle.

When a user decides to follow the recommended workout, the device will also provide real-time guidance, ensuring the user stays in the proper intensity. The plan is presented to the user on the screen, typically showing a measure of time for the workout, a distance, a speed, or a target heart rate. During the workout, the device will monitor the user's heart rate and speed, if available, and provide real-time feedback on whether the user is staying in the proper intensity zone.

After the workout, the user is presented with a report on how the workout went, how it affected their fitness, how long they should recover for, and what the future workout recommendation will be. If the workout seemed too hard or too easy, the device will adjust future workouts to be more appropriate to the individual user's fitness level. The adaptive training guidance feature is not a compulsory feature of the watch, and users may choose to follow it all of the time, some of the time, or never.

3.2. Data Collection and Sample

The target population of this intervention study was young elderly people. The data collection was done in the summer 2019. The participants were recruited from a Finnish University of the 3rd Age (UTA), which works as a meeting spot for elderly people. 80% of the participants were recruited during UTA's weekly scientific lecture session and the rest were recruited via snowball method. 62 people signed up for the study of which 30 people were randomly chosen as participants for this intervention, meaning the participants' PA level did not have a role in the sample selection. The 30 participants were provided with a sport and wellness technology digital coach device for the intervention period of 10–12 weeks. The reason for limiting the number of participants to 30 was due to the number of available digital coach devices. To make the user experience as convenient and pleasant as possible, the participants were asked to use the device in the way that best suited them, though encouraging them to wear it as much as possible. In other words, during the intervention period, participants used the digital coach and conducted PA purely according to their own preferences. Choosing to follow the PA program provided by the digital coach was completely voluntary.

The data was collected using qualitative semi-structured interviews, which took place immediately after the intervention period. A semi-structured interview includes an incomplete script, but typically a pre-formed structure is prepared for the interviewer to follow [45]. The interview script had mostly open questions. In the few occasions there was a closed question, participants were encouraged to elaborate if so desired. The interview script comprised of the following sections: 1. Background information, 2. Expectations for digital coaching, 3. User experiences, 4. Adaptive training guidance and real-time feedback,

5. Effects of the digital coach on exercising and 6. Ideal digital coach. Sections 2–6 also included questions specifically related to motivation and self-efficacy issues. After the 10–12-week intervention period the participants were interviewed separately or in groups of two people. The total number of interviews was 26. The interview lengths varied from 46 to 81 min and on average lasted about 60 min.

Of the participants, 20 were female and 10 were male. Their ages varied between 61 and 76 years. We also determined their PA class via categories derived from the Finnish National Sport Survey [46]. This classifies people into seven PA categories based on their frequency and intensity of PA as well as central reasons for being physically active. The categories are: competition athletes, fitness athletes, fitness participants, physically active for health, active in commuting and non-exercise, occasionally active, and inactive or sedentary. This information regarding PA class was determined retrospectively after the study had already finished. Table 1 below presents descriptive statistics of the participants.

Table 1. Background of the participants.

	Male	Female	Total
N	10	20	30
Age			
60–65 years	4	3	7
66–70 years	3	12	15
71–75 years	2	5	7
>75 years	1	0	1
Socioeconomic status			
Working	1	1	2
Retired	9	19	28
Physical activity class			
Fitness athletes	1	1	2
Fitness participants	5	6	11
Physically active for health	2	9	11
Active in commuting and non-exercise	1	3	4
Occasionally active	1	0	1
Sedentary	0	1	1

Out of all the participants, eight participants did not have any previous experience with any kind of sport and wellness technology devices or applications. The other 22 had some experience with heart rate monitors, activity bracelets, PA applications, or pedometers. However, with most participants the previous experiences were limited to testing or short period usage. None of the participants had previous experience with a digital coach device or application.

3.3. Data Analysis

Thematic analysis method was chosen for this study. This method is the most widely used analysis method in qualitative research [47]. It is used for "analyzing, identifying and reporting patterns within data" [48] p. 79. Thematic analysis enabled studying, identifying and comparing the occurring themes from the data set, and also helps in organizing and describing the data set and its aspects in rich detail. In the analysis phase the guidelines of [48] were followed. The guidelines were applied in a flexible manner in order to fit the research questions and data.

To increase the understanding of the analysis process, a more detailed example of the analysis of one participant's interview data will be provided. The interview's structure included the following sections: exercising habits in general, expectations about digital coaching and its effects, usage of the digital coach, adaptive training guidance and feedback, effects of digital coaching on behavior and motivation, digital coaching in general, and the ideal digital coach. Each section provided more specific questions related to a topic. For example, the section regarding exercise motivation included questions about general exercise motivation, how the digital coach can affect motivation, in what ways digital coach affects self-efficacy, and how could a digital coach affect a user's motivation. However, answers related to exercise motivation and overall usage experiences could also found in many sections. This was because interview questions were semi-structured and the participants easily linked motivation and overall usage of digital coach to many different interview sections. The data analysis continued by getting familiar with the data and transcribing the relevant parts of the interviews under each interview section. In the analysis process, a recursive process was used, allowing moving back and forth between the analysis phases. The analysis was performed section-by-section. In order to clarify the analysis process, the answers from each person were written down in an Excel file to better find the similarities, differences and themes related to each topic. The answers from different participants were then compared between each other. The most highlighted themes and issues discovered during this comparison process are reported in the following findings section. The data analysis was performed by a writer who was also responsible for doing the interviews.

4. Findings

The findings are presented in two chapters with each focusing on a different research question. The chapters are presented in the same order as the research questions they aim to answer.

4.1. Effects on Exercise Motivation

The participants were asked what has previously motivated them to exercise and take care of their wellbeing in general. The most common motivator was to maintain their fitness and mobility regardless of the challenges of aging. Other important motivators were the fact that exercising brings pleasure and that it has already become a habit throughout their entire lives. A few participants also mentioned weight loss and competitions as their motivators. In general, participants also considered themselves to be relatively knowledgeable when it comes to understanding the basics of physical activity and health. When asked about their expectations towards the study, participants had expected that using a digital coach would slightly increase their physical activity levels by making exercising more goal-oriented or by providing encouraging and educational feedback and instructions. This indicates that the participants were expecting that a digital coach as proxy agent could be capable of bringing themselves closer to their physical activity goals than they can achieve alone.

Out of the 30 participants, 26 reported that using a digital coach had had a positive effect on their exercise motivation. These positive effects took place primarily at the beginning of the study but also in the later phase when participants were able to see the result of their work from the watch data and feedback. It seemed that the most important way a digital coach can affect exercise motivation is by providing personalized data about current fitness level and physical activity and about the progress that a person has made. This data made exercising more goal-oriented as well as make the user more knowledgeable about their physical activity and wellbeing. When looking at this from the point of view of self-determination theory it could be seen that increased knowledge about personal fitness and its progress can increase the feeling of competence. In addition to the increased knowledge some participants also found the positive messaging and acknowledgements from the digital coach to bring pleasure and support and increase motivation. This impact on motivation could be seen as being part of the feeling of relatedness.

Seven participants reported that after the study they felt more confident about themselves. The participants suggested that the reason for increased self-efficacy related to exercising was the perceived increase in physical activity provided by the received data. For some participants the increased self-efficacy was less related to exercising but more related to their ability to use modern technology. Four participants felt less confident after the study but this decrease in self-efficacy was only related to the use of technology rather than their ability to exercise.

In general participants found digital coaching to be motivating and suitable for many types of users. Some participants felt that particularly people who do not exercise enough would benefit more from a digital coach since the device would create positive pressure for them to start exercising more. Some participants also said that younger people whose exercising is more goal-oriented would benefit more from a digital coach. A common opinion was that the most motivating part of using a digital coach is the received data that will teach the user more about themselves. However, as one participant reminded: "*Exercising should not be too technological and goal-oriented but rather it should be fun*" (male, 74 y, participant 22). Participants also felt that no matter the age it is important that users have an initial interest in technology. One participant commented that age could be a factor when finding a suitable target group for digital coaching: "*Even though this could be a good product for elderly people it could be challenging for us since we already seem to know very well how our bodies behave*" (female, 71 y, participant 10).

4.2. Usage Experiences

4.2.1. General Experiences in Using a Digital Coach

In the beginning of the intervention the participants received instructions on how to start using the watch. However, the actual initialization setup was left for the participants to do themselves. One third of the participants reported not having major problems in setting up the watch but the remaining 20 participants reported having problems. Most of them needed extra help from family members, relatives or even sports store service people. Many participants highlighted that the instructions that came with the digital coach needed to be clearer. Some participants also wished that the researcher had physically helped them in the setup process, which could have made the start of the intervention easier. Participants who felt the most confident in their abilities to learn to use the new device were usually the younger participants close to ages 60–65.

Almost all participants reported wearing the device all the time during the 10–12-week intervention period. Most participants wore it also during the night. Only a few participants reported wearing the device less as time went by. The participants were interested in many different features of the device. The most often used features in the watch were step counting, distance measurement, heart rate monitoring and sleep analysis. The next most popular features were the training calendar and the adaptive training guidance. Some participants were also paying attention to the stress level monitoring but almost none of them really trusted the stress information or at least did not understand the reasons behind it.

Participants were also asked what they thought were the most positive and the most negative issues related to using a digital coach. Since most of the participants had not regularly used a sport and wellness technology device before, the most positive thing that surprised them was receiving interesting data about their own training and performance. Getting various types of data helped participants better keep track of their exercising: "*It seemed I was receiving realistic information about what I was doing. It seemed I was doing less exercising than I thought I was doing*" (female, 66 y, participant 4). Some participants felt that wearing a digital coach created more pressure, which made them feel they needed to exercise more. However, this pressure was usually considered positive. The appearance and the comfort of the device received positive comments. Many participants also said that getting comments and remarks from the device made them feel like someone cared about what they are doing. Receiving information about their accomplishments made them feel

proud of themselves. Participants were not interested in sharing their data on social media; however, they found it generally interesting to discuss their digital coach experiences with friends and family.

The biggest negative issues related to usability since many participants had problems learning how to use the device. As one participant said. "*It is easy to lose your motivation towards learning to use a new device if it takes too long*" (female, 68 y, participant 19). pAlso, some participants felt that the buttons or the text on the screen was too small, which made them less confident and less excited to use the product. Often, participants forgot to start and/or stop the watch when doing an exercise and this was considered annoying. A few participants felt that the 10–12-week intervention period was too short and would have liked to keep on learning more about the watch and about themselves. The accuracy of the data was also questioned by some participants especially since the heart rate measurements did not always seem consistent with the participants' own feelings.

Many participants reported having an increased interest towards sport and wellness technology in general but added that it takes time and patience to really get the full benefits from the device. Two participants reported feeling less confident about sport and wellness technology after the intervention due to usability difficulties: "I felt less confident since I felt I was not able to utilize the product efficiently enough" (female 69, participant 5). Seven participants felt more confident on their abilities to use these technologies.

4.2.2. Adaptive Training Guidance and Feedback

At the beginning of the intervention the participants input their background information into the watch. After that the watch asked the users to do a short aerobic workout based on which it estimated the user's fitness level. Based on this information the watch was able to create an initial exercise plan for aerobic fitness for the users to follow if so desired. The users were also able to choose whether they wanted to maintain, improve or quickly improve their fitness; that way they had an option to choose how hard they wanted their exercise program to be. On average participants chose the middle level, which was to improve your fitness. Their initial reaction to the program was that it seemed relatively easy and doable. Only one participant felt that the program seemed too hard for them; however, after two weeks of following the program their feelings had changed: "*In the beginning I thought this is too hard since I don't feel I am able to do anything. After two weeks I realized that the watch might know me even better than myself*" (female, 62 y, participant 30).

Even though most participants felt confident in their abilities when seeing the program for the first time, some participants had negative first reactions since it seemed too easy and included less exercise compared to what they were already doing. This made the users speculate what the digital coach was basing its suggestions on, and whether the exercise program was going to be effective. Most participants who shared these feelings did not follow the recommended exercise plan but rather continued to exercise the way they were used to. Another questionable issue related to adaptive training guidance was that some participants did not feel the timing of the exercises fit their current weekly plan. They wanted to determine for themselves which days they exercised and which were rest days. In all, many participants did not follow the exercise plan precisely but adapted it to better suit themselves.

Despite many participants not following the exercise program given by the digital coach very strictly or at all, they felt that having a program tailored for their own fitness was able to bring a boost to their exercising. The adaptive training guidance was said to create positive pressure to get moving and made exercising more goal-oriented by bringing more structure to the week.

Another feature guiding the participants' exercising was real-time feedback by giving them signals whether the pace of their exercise was optimal for them. Almost all participants tested this feature, but most did not end up using it or following its advice. The reason for this was that users wanted to determine their pace themselves, and constant signaling was considered more of an annoyance than helpful. A few participants who

followed the real-time feedback information reported that they had made changes to their exercising which usually meant reducing their pace. As one participant said: "*It is good to have a reminder that one does not have to train so hard at this age*" (female, 62 y, participant 30). When participants were asked after the intervention whether they would like to use adaptive training guidance or the real-time feedback feature in the future, 22 participants showed interest in the real-time feedback feature and 15 participants mentioned interest in adaptive training guidance. However, participants also felt these features could be further developed to be more accurate and more personalized, and that way they would be more interesting and helpful for the users. As one participant commented: "*I don't doubt that digital coach would be useful, but it needs to be a lot more personalized and even have an option to personalized it by myself*" (male, 71 y, participant 3).

4.2.3. Perceived Influence on Physical Activity and Fitness

A third of participants reported having made changes to their physical activity during the study period. The most common change was the increased frequency and length of their walking exercises. Other changes were related to general exercising, such as having a more planned training routine or for example taking walking poles along. Also, one participant noted that slowing down their pace can have a positive outcome on general fitness: "*I don't always have to go with a very fast pace, slower walks seem to be meaningful too*" (female, 68 y, participant 14).

Even though only a few participants reported feeling that their fitness level had increased during the intervention period, most participants reported learning new things about themselves during the intervention. Some people claimed to be more realistic about their physical fitness since they had seen actual physical data. Many participants also learned more about their recovery during sleep as well as between exercise periods. As one person reported: "*I am now more capable of taking to account how tired my body is when planning exercising and therefore it is easier to prevent overtraining*" (male, 62 y, participant 15). Some participants were surprised at how fast their physical fitness could improve. However, most realized that it takes time and patience to see results. Only a few participants were following their stress level and its development from the digital coach. However, participants did not appear to make any changes based on the stress level information but were only looking at the information out of interest.

After the study participants reported that they wished to learn more regarding their physical activity and wellbeing. The participants felt that more detailed data and explanations about sleeping and recovery was missing. Some participants would have liked more deeper knowledge on what exactly the digital coach is basing its data and personalized suggestions on.

4.2.4. Ideal Digital Coach

Participants were also asked what their ideal digital coach would be like. Half of the participants said they would prefer a watch since it is easy to wear. The other half would be happy to have their digital coach as an application maybe combined with a heart rate belt to receive more data. Most people agreed that since it can be challenging to read the feedback and information from the watch, digital coach information should also be able to be read from a computer or at least from an application.

When participants were asked what type of information they would want their ideal digital coach to provide, most said they would be satisfied having basic training related information that would include recovery and sleep data. However, many participants wanted health related information from their digital coach such as blood pressure, blood sugar, nutrition, energy consumption or tips for muscle training. Notifications related to eating times, taking medication, or even sleeping times were also considered interesting possible additions in the future development of digital coaching solutions.

After the intervention participants were asked whether they would choose a human coach or a digital coach as their mentor in the future. Exactly half of the participants said

they would choose a human coach. Their reasoning was that they would prefer a human connection and the ability to communicate with someone. A human coach would also offer training plans with more explanations and guidance, and it would be more personalized. The other half who chose a digital coach felt that it would provide them more freedom and independence, since the digital coach is always around. It was also considered a more affordable option. As one participant said: "*A digital coach will continue to cooperate with me as long as I want, and it also provides me with unbiased information*" (female, 71 y, participant 10). However, almost all participants agreed that having both a human coach and a digital coach would be the ideal situation. When looking at participants' wishes related to their ideal coach it could be interpreted that the lack of feeling of relatedness is a reason for many young elderly participants to choose a human coach over a digital coach. However, it does seem that participants who would choose a digital coach over a human coach appreciated the feeling of autonomy that a digital coach would provide.

5. Discussion and Conclusions

The main aim of this qualitative study was to find out what kind of experiences young elderly encounter with sport and wellness technology digital coaching solutions and how they perceive the use and influence of such solutions in their pursuit of reaching or maintaining a physically active lifestyle. This study approached the topic from an exercise psychology angle focusing more closely on self-efficacy and motivation. However, since the focus was also to find out what type of digital coaching best suits this target group the paper also focused on issues related to user experience. The research questions were the following: First, how does sport and wellness technology digital coaching influence motivation to exercise, particularly related to feelings of autonomy, competence, relatedness, and self-efficacy in young elderly people for maintaining and achieving a more physically active lifestyle? Second, how do young elderly users describe their experiences of using a digital coach? This topic encompasses the experiences this population had while using a sport and wellness technology digital coach, their perceptions on the central feature, the adaptive training guidance of a digital coach, and their opinions on a digital coach's ability to support PA and fitness, including ideas on the kind of digital coach device that would be ideal for young elderly users.

5.1. Theoretical Contribution

The findings of the study highlight that sport and wellness technology digital coaching can seem interesting to the young elderly target group. The biggest reason that seemed to motivate participants towards exercising were learning new things about themselves and their exercising due to the received data from the digital coach. Participants also found the feedback and messages motivational, making them feel proud of their exercise accomplishments as well as gave a feeling that someone cared about whether they were staying active or not. It also seemed that tracking one's exercising made people more aware about their own PA and what they are capable of doing.

Looking at the results from a theoretical point of view it seems that a digital coach can have an effect on young elderly people's exercise self-efficacy particularly by providing them accurate and unbiased information about their exercising and fitness level and thus making exercising more goal-oriented. These findings support the findings of [25], stating that mobile solutions have an effect on elderly people's PA self-efficacy. For some people the digital coach made them realize they are not as active as they thought. For other participants the information received made them realize they are more capable of doing PA that they thought. This suggests that a digital coach could affect the feeling of competence related to PA. In both cases the feedback was seen as motivational, encouraging the participants to push even harder. Receiving messages from the digital coach increased the feeling of relatedness since it made them feel someone, even a device, cared about what they were doing.

Participants did not necessarily feel the need to follow the adaptive training guidance they received from the digital coach. Most participants already had exercise routines and wanted to stick with their own schedule rather than modify their plans according to new advice. This shows that for the participants in the study having autonomy was important. Participants also felt the personalized programs created by the adaptive training guidance were too easy and this decreased their interest in following the program. However, some participants received extra motivation since the program did not seem too demanding in the beginning. This made them feel more confident in their abilities. Also, the real-time feedback was perceived as an interesting feature. However, most participants did not use it since they felt the pace the device was suggesting was not suitable for their own familiar pace. Despite these, most participants said they would be interested in using digital coaching features in the future, especially if some small modifications would be made. According to previous research [49] the use of digital coaching has been viewed as having potential in increasing exercise motivation by increasing the feeling of autonomy. Based on these current results it can also be seen that having the need for autonomy might also prevent young elderly people from stepping out of their usual exercise routines and trying something different.

The biggest difficulties for young elderly people regarding the usage of digital coaching were related to usability. Many participants wished for more help when trying to set up the digital coach and start using it. Therefore, it can be seen that young elderly people do not necessarily feel confident and have high self-efficacy when it comes to adapting to new sport and wellness technology. These difficulties in the beginning might then also affect the actual usage of the digital coach in the later phase. Participants also highlighted some changes related to self-efficacy for using technology in general. It seemed that difficulties in using digital coaching did easily lower the participants' self-efficacy for other technology, and positive experiences increased participants' self-efficacy. In general participants wished the digital coach would be easier to use and have more clear messaging. Participants also said that digital coaching could be made even more personalized in the future.

Looking at the findings from a proxy agent perspective it can be seen that a technological device can work as a PA proxy agent for young elderly people by making them feel more competent in exercising independently. This finding supports the findings from [50] which highlighted that a physical activity application can be effective in promoting exercise self-efficacy among aged people. Even though digital coaching can work for young elderly participants it is clear that human contact and coaching is still very much appreciated. Therefore, the ideal coaching for this target group would be consist of both digital and human coaching. It is clear that a digital coach does not yet have all the needed qualities that a human coach can offer. Different users had different needs and wishes and therefore it can be said that ideal digital coaching means different things to different people. This idea supports the findings of [51] that highlighted the importance of a person-based approach, especially in digital interventions. However, the role of supportive, educational, and motivational messaging seems to play an important role in this target group irrespective of personalized wants and needs.

5.2. Practical Contribution

When considering the practical contributions of the study it seems important that the digital coaching devices and applications would be made more user friendly in order to attract young elderly participants. Font size should be big enough, buttons easy to use and in general, the digital coach needs to be easy to use. Difficulties in the beginning of the user experience affect the usage later on. It seems that sport and wellness technology can increase young elderly people's knowledge regarding their own PA which leads to positive results. However, this feedback and messaging should also be presented clearly and in an interesting and more personalized way. These results support the previous findings of [32]. In the target group of young elderly, positive messaging seems to have a positive effect on their belief in their own abilities.

6. Limitations and Future Research

There are some limitations to this study that are worth noting. First, the findings of this study are based on the user experience of one particular sport and wellness technology digital coach. It is understandable that if the study was repeated with a different type of digital coach some of the findings could vary. Secondly, it is worth noting that the study period lasted only three months which is a relatively short time period. Especially for the target group of young elderly, learning to use the device might take longer. Thirdly, the study consisted only of 30 participants. It would be beneficial for the study to be repeated using a larger sample size and/or a different type of digital coach and possibly with a longer time period. It is important to keep in mind that since participation was on a volunteer basis, it was hard to find less physically active young elderly people to join who would be interested in the study. Therefore, most participants were at least somewhat physically active.

Further studies could also focus on studying different target groups. However, it is still worth continuing to conduct research with the young elderly target group in this area.

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References

1. United Nations. World Population Ageing 2019. Available online: https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Highlights.pdf (accessed on 30 April 2022).
2. WHO (World Health Organization). World Health Statistics 2020—Monitoring Health for theSDGs. 2020. Available online: https://apps.who.int/iris/bitstream/handle/10665/332070/9789240005105-eng.pdf (accessed on 30 April 2022).
3. Eurostat. Population Structure and Ageing. 2020. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php/Population_structure_and_ageing (accessed on 30 April 2022).
4. United Nations. Sustainable Development. 2022. Available online: https://sdgs.un.org/goals/goal3 (accessed on 8 May 2022).
5. McPhee, J.S.; French, D.P.; Jackson, D.; Nazroo, J.; Pendleton, N.; Degens, H. Physical activity in older age: Perspectives for healthy ageing and frailty. *Biogerontology* **2016**, *17*, 567–580. [CrossRef] [PubMed]
6. Hoogendijk, E.O.; Afilalo, J.; Ensrud, K.E.; Kowal, P.; Onder, G.; Fried, L.P. Frailty: Implications for clinical practice and public health. *Lancet* **2019**, *394*, 1365–1375. [CrossRef]
7. De Vries, H.J.; Kooiman, T.J.; van Ittersum, M.W.; van Brussel, M.; de Groot, M. Do activity monitors increase physical activity in adults with overweight or obesity? A systematic review and meta-analysis. *Obesity* **2016**, *24*, 2078–2091. [CrossRef] [PubMed]
8. Larsen, R.T.; Christensen, J.; Juhl, C.B.; Andersen, H.B.; Langberg, H. Physical activity monitors to enhance amount of physical activity in older adults—A systematic review and meta-analysis. *Eur. Rev. Aging Phys. Act.* **2019**, *16*, 7. [CrossRef] [PubMed]
9. Romeo, A.; Edney, S.; Plotnikoff, R.; Curtis, R.; Ryan, J.; Sanders, I.; Crozier, A.; Maher, C. Can smartphone apps increase physical activity? Systematic review and meta-analysis. *J. Med. Internet Res.* **2019**, *21*, e12053. [CrossRef]
10. Kari, T.; Kettunen, E.; Moilanen, P.; Frank, L. Wellness Technology Use in Everyday Life: A Diary Study. In Proceedings of the 30th Bled eConference "Digital Transformation—From Connecting Things to Transforming Our Lives", Bled, Slovenia, 18–21 June 2017; University of Maribor: Bled, Slovenia, 2017; pp. 279–294.
11. Wang, J.B.; Cataldo, J.K.; Ayala, G.X.; Natarajan, L.; Cadmus-Bertram, L.A.; White, M.M.; Madanat, H.; Nichols, J.F.; Pierce, J.P. Mobile and Wearable Device Features That Matter in Promoting Physical Activity. *J. Mob. Technol. Med.* **2016**, *5*, 2–11. [CrossRef]
12. Gordon, M.; Althoff, T.; Leskovec, J. Goal-setting and achievement in activity tracking apps: A case study of MyFitnessPal. In Proceedings of the World Wide Web Conference, San Francisco, CA, USA, 13–17 May 2019; ACM: New York, NY, USA, 2019; pp. 571–582.
13. Rockmann, R. Don't Hurt Me . . . No More? An Empirical Study on the Positive and Adverse Motivational Effects in Fitness Apps. In Proceedings of the 27th European Conference on Information Systems, Stockholm & Uppsala, Sweden, 8–14 June 2019.

14. Kari, T.; Koivunen, S.; Frank, L.; Makkonen, M.; Moilanen, P. The expected and perceived wellbeing effects of short-term self-tracking technology use. *Int. J. Netw. Virtual Organ.* **2017**, *17*, 354–370. [CrossRef]
15. Shilts, M.K.; Horowitz, M.; Townsend, M.S. Goal setting as a strategy for dietary and physical activity behavior change: A review of the literature. *Am. J. Health Promot.* **2004**, *19*, 81–93. [CrossRef]
16. Kettunen, E.; Kari, T. Can Sport and Wellness Technology Be My Personal Trainer?: Teenagers and Digital Coaching. In Proceedings of the 31th Bled eConference. Digital Transformation: Meeting the Challenges, Bled, Slovenia, 17–20 June 2018; University of Maribor: Bled, Slovenia, 2018; pp. 463–476.
17. Adams, S.; Niezen, M. Digital 'solutions' to unhealthy lifestyle 'problems': The construction of social and personal risks in the development of eCoaches. *Health Risk Soc.* **2016**, *17*, 530–546. [CrossRef]
18. Blok, J.; Dijkhuis, T.; Dol, A. Toward a generic personalized virtual coach for self-management: A proposal for an architecture. In Proceedings of the 9th International Conference on eHealth, Telemedicine, and Social Medicine, Nice, France, 19–23 March 2017.
19. Kranz, M.; Möller, A.; Hammerla, N.; Diewald, S.; Roalter, L.; Ploetz, T.; Olivier, P. The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices. *Pervasive Mob. Comput.* **2013**, *9*, 203–215. [CrossRef]
20. Kari, T.; Rinne, P. Influence of Digital Coaching on Physical Activity: Motivation and Behaviour of Physically Inactive Individuals. In Proceedings of the 31st Bled eConference, Bled, Slovenia, 17–20 June 2018; University of Maribor: Bled, Slovenia, 2018; pp. 127–145.
21. Kettunen, E.; Kari, T.; Makkonen, M.; Critchley, W. Digital Coaching and Athlete's Self-Efficacy—A Quantitative Study on Sport and Wellness Technology. In Proceedings of the 12th Mediterranean Conference on Information Systems, Corfu, Greece, 28–30 September 2018.
22. Kettunen, E.; Critchley, W.; Kari, T. Can Digital Coaching Boost Your Performance?—A Qualitative Study among Physically Active People. In Proceedings of the 52nd Hawaii International Conference on System Sciences, Maui, HI, USA, 14–18 January 2019.
23. Helmefalk, M.; Marcusson, L.; Sell, A. "Who cares about fireworks?"–A Study on Digital Coaching, Gamification and Exercise Motivation. In Proceedings of the 53rd Hawaii International Conference on System Sciences, Maui, HI, USA, 7–10 January 2020.
24. Carlsson, C.; Walden, P. Digital wellness services for young elderly—A missed opportunity for mobile services. *J. Theor. Appl. Electron. Commer. Res.* **2016**, *11*, 20–34. [CrossRef]
25. Changizi, M.; Kaveh, M.H. Effectiveness of the mHealth technology in improvement of healthy behaviors in an elderly population - a systematic review. *mHealth* **2017**, *27*, 1–9. [CrossRef]
26. Muellmann, S.; Forberger, S.; Möllers, E.; Bröring, E.; Zeeb, H.; Pischke, C.R. Effectiveness of eHealth interventions for the promotion of physical activity in older adults: A systematic review. *Prev. Med.* **2018**, *108*, 93–110. [CrossRef]
27. Yerrakalva, D.; Yerrakalva, D.; Hakna, S.; Griffin, S. Effects of mobile health app interventions on sedentary time, physical activity, and fitness in older adults: Systematic review and meta-analysis. *J. Med. Internet Res.* **2019**, *21*, e14343. [CrossRef]
28. Stockwell, S.; Schofield, P.; Fisher, A.; Firth, J.; Jackson, S.E.; Stubbs, B.; Smith, L. Digital behavior change interventions to promote physical activity and/reduce sedentary behavior in older adults: A systematic review and meta-analysis. *Exp. Gerontol.* **2019**, *120*, 68–87. [CrossRef]
29. Broekhuizen, K.; de Gelder, J.; Wijsman, C.A.; Wijsman, L.W.; Westendorp, R.G.; Verhagen, E.; Slagboom, P.E.; de Craen, A.J.; van Mechelen, W.; van Heemst, D.; et al. An internet-based physical activity intervention to improve quality of life of inactive older adults: A randomized controlled trial. *J. Med. Internet Res.* **2016**, *18*, e74. [CrossRef]
30. Lentferink, A.J.; Oldenhuis, H.K.; de Groot, M.; Polstra, L.; Velthuijsen, H.; van Gemert-Pijnen, J.E. Key components in eHealth interventions combining self-tracking and persuasive eCoaching to promote a healthier lifestyle: A scoping review. *J. Med. Internet Res.* **2017**, *19*, e277. [CrossRef]
31. Mezei, J.; Sell, A.; Walden, P. Digital Coaching—An Exploratory Study on Potential Motivators. In Proceedings of the 53rd Hawaii International Conference on System Sciences, Maui, HI, USA, 7–10 January 2020.
32. Petsani, D.; Kostantinidis, E.I.; Diaz-Orueta, U.; Hopper, L.; Bamidis, P.D. Extending Exergame-Based Physical Activity for Older Adults: The e-Coaching Approach for Increased Adherence. In Proceedings of the International Conference on Information and Communication Technologies for Ageing Well and e-Health, Madeira, Portugal, 22–23 March 2018; pp. 108–125.
33. Ryan, R.M.; Deci, E.L. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemp. Educ. Psychol.* **2000**, *25*, 54–67. [CrossRef]
34. Bandura, A. *Social Foundations of Thought and Action: A Social Cognitive Theory*; Prentice Hall: Englewood Cliffs, NJ, USA, 1986.
35. Ryan, R.M.; Williams, G.C.; Patrick, H.; Deci, E.L. Self-determination theory and physical activity: The dynamics of motivation in development and wellness. *Hell. J. Psychol.* **2009**, *6*, 107–124.
36. Bandura, A. Health promotion from the perspective of social cognitive theory. *Psychol. Health* **1998**, *13*, 623–649. [CrossRef]
37. McAuley, E. Self-efficacy and the maintenance of exercise participation in older adults. *J. Behav. Med.* **1993**, *16*, 103–113. [CrossRef]
38. Moritz, S.E.; Feltz, D.L.; Fahrbach, K.R.; Mack, D.E. The relation of self-efficacy measures to sport performance: A meta-analytic review. *Res. Q. Exerc. Sport* **2000**, *71*, 280–294. [CrossRef]
39. Oman, R.F.; King, A.C. Predicting the adoption and maintenance of exercise participation using self-efficacy and previous exercise participation rates. *Am. J. Health Promot.* **1998**, *12*, 154–161. [CrossRef]
40. Bandura, A. Self-efficacy Mechanism in Human Agency. *Am. Psychol.* **1982**, *37*, 122–147. [CrossRef]
41. Feltz, D.; Lirgg, C. Self-efficacy beliefs of athletes, team, and coaches. In *Handbook of Sport Psychology*, 2nd ed.; Singer, R., Hausenblas, H., Janelle, C., Eds.; John Wiley & Sons: New York, NY, USA, 2001; pp. 340–361.

42. Shields, C.; Brawley, L. Preferring Proxy-agency: Impact on Self-efficacy for Exercise. *J. Health Psychol.* **2006**, *11*, 904–914. [CrossRef]
43. Miles, B.; Huberman, A.M. *Qualitative Data Analysis*; Sage Publications Ltd.: Thousand Oaks, CA, USA, 2009.
44. Suunto. Suunto Fitness 3 Black—Training Watch with Activity Tracking. 2020. Available online: https://www.suunto.com/en-gb/Products/sports-watches/suunto-3-fitness/suunto-3-fitness-all-black/ (accessed on 14 July 2020).
45. Myers, M.; Newman, M.M. The Qualitative Interview in IS Research: Examining the Craft. *Inf. Organ.* **2007**, *17*, 2–26. [CrossRef]
46. Finnish Sports Federation. *Kansallinen Liikuntatutkimus 2009–2010: Aikuis-Ja Senioriliikun-Ta*; National Sports Study 2009–2010: Adult and Elderly Physical Activity Report; Finnish Sports Federation: Helsinki, Finland, 2011.
47. Guest, G.; MacQueen, K.M.; Namey, E.E. *Applied Thematic Analysis*; SAGE: Los Angeles, CA, USA, 2012.
48. Braun, V.; Clarke, V. Using thematic analysis in psychology. *Qual. Res. Psychol.* **2006**, *3*, 77–101. [CrossRef]
49. Kettunen, E.; Kari, T.; Makkonen, M.; Frank, L.; Critchley, W. Young Elderly and Digital Coaching: A Quantitative Intervention Study on Exercise Self-Efficacy. In *33rd Bled eConference: Enabling Technology for a Sustainable Society, Online, 28–29 June 2020*; Pucihar, A., Borstnar, M.K., Bons, R., Cripps, H., Sheombar, A., Vidmar, D., Eds.; University of Maribor Press: Maribor, Slovenia, 2020; pp. 469–484.
50. Kari, T.; Makkonen, M.; Frank, L.; Kettunen, E. Does Physical Activity Application Use Promote Self-Efficacy for Exercise? A Study among Aged People. In Proceedings of the 55th Hawaii International Conference on System Sciences (HICSS 2022), Maui, HI, USA, 4–7 January 2022; pp. 1438–1447.
51. Yardley, L.; Morrison, L.; Bradbury, K.; Muller, I. The person-based approach to intervention development: Application to digital health-related behavior change interventions. *J. Med. Internet Res.* **2015**, *17*, e30. [CrossRef] [PubMed]

VII

CRITICAL EXPERIENCES WITH SPORT AND WELLNESS TECHNOLOGY DIGITAL COACH – DIFFERENCES BETWEEN YOUNG ADULTS AND YOUNG ELDERLY

by

Eeva Kettunen, Tuomas Kari, Will Critchley & Lauri Frank, 2022

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