Technology, Knowledge and Learning
https://doi.org/10.1007/s10758-023-09721-2

ORIGINAL RESEARCH

# The Power of a Human Bridge: Motivating Older Adults to Long-Term Engagement with Touchscreen Devices in a SDT-Based Learning Session

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Accepted: 21 December 2023
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**Abstract**
The rapid development of digital technology and its pervasiveness in everyday life requires everybody to develop the skills necessary to engage with such technology for one's mundane tasks and communication needs. The first steps towards developing these skills can be particularly challenging for older adults, who might need to fundamentally adapt their learned and long-practiced routines. Maintaining motivation in these initial steps is crucial for sustained engagement. The present study examines factors that can contribute to promote motivation in a facilitated learning session based on Self-Determination-Theory. We conducted a longitudinal qualitative study in which we examined people's motivation to engage with digital technology, based on observational data as well as interviews with 33 older adults before and immediately after participating in a facilitated learning session. To investigate sustained effects on motivation, further interviews were conducted 3 months after participation. We found that satisfying the need for relatedness by learning together with peers and receiving support from facilitators was a prerequisite for this target group to develop a sense of competence and autonomy, which can lead to sustained motivation. Long-term motivational effects could not only be explained by the immediate effects of the learning intervention, but were identified to be dependent also on individual needs and predispositions. These findings were aggregated in a typology that identifies relevant influence factors and explains the potential motivational effects for different parts of the target group. It supports learning and technology designers to adapt to the addressed user group.

**Keywords** SDT · Elderly people · Sustained motivation

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Published online: 24 January 2024

## 1 Introduction

The use of digital technology has the potential to improve the daily lives of older adults—it can support an independent lifestyle (Pal et al., 2017) and can reduce loneliness through more intensive contact with family members or friends (Delello & McWhorter, 2017; Szabo et al., 2019). Furthermore, an increasing number of today's social, economic, and societal means of participation as well as daily activities inherently involve the use of digital tools (Barnard et al., 2013; Charness & Boot, 2022). The skilled use of these digital tools thus is a precondition for maintaining agency in one`s own life (Boudreau & Robey, 2005).

This potential of digital technology to transform the professional and private lives of nearly everybody throughout society today has been evident for decades (Evangelista et al., 2014; Fenwick & Edwards, 2016). However, novel forms of interaction with one`s environment and new ways of communicating with others in spatially and temporally distributed settings require individuals to develop new cultural techniques (Bollin & Micheuz, 2018) and new routines in performing their daily chores (Schmid et al., 2017). The rapid evolvement of digital technology in general and mobile devices in particular in the last years and their ubiquitous availability has led to a pervasive encounter with them throughout all areas of society (Ling et al., 2020). Frustrating experiences when dealing with or using new technologies has thus become a common phenomenon for many people (ibid.). The discrepancy between one's perceived capabilities and the environment's implicit or explicit demands can easily lead to a reluctance of using novel digital technology or even ignoring it and its potentials (He & Freeman, 2010; Porter & Donthu, 2006; Underwood, 1997). The objective "novelty" of a particular technological innovation is not relevant here—challenges arise from individual perceptions of novelty and relevance, which depend on people's prior experiences. Many initiatives in research and practice have addressed this issue and set out to conceptualize digital skills (Oberländer et al., 2020) and propose didactical measures to support their development. They, however, implicitly assume that the affected people are aware of the need of developing these skills and are willing to do so (Yu et al., 2017).

Obstacles when learning to deal with new technologies are omnipresent in particular for people beyond their working life (Friemel, 2016). The older population often has not had experiences with digital technologies in their workplace, which makes digital adoption in private life even more challenging (Chiu & Liu, 2017; Wortley et al., 2017). Although digital adoption is rising among the older population (Stone et al., 2017), there are still considerable differences between younger and older generations in that respect (Eurostat, 2021; Statistik Austria, 2021): In the EU, in 2020, 61% of those aged 64 to 74 used the internet, while 98% of those aged 16 to 24 were online (Eurostat, 2021). The reasons why older adults do not use or interact with new technologies, however, are manifold because of different social and individual determinants (Friemel, 2016). This makes it necessary to explicitly address older adults as a target group to get deeper insights into how to address their individual needs and design the introduction of digital technologies according to their capabilities and needs.

In general, the motivation of people influences what they learn and engage with (Ryan & Deci, 2020). Empirical evidence shows that motivation and wellbeing is critical to effectively engage with digital technology in learning sessions (Peters et al., 2018). A theoretical framework that allows for insights on how people develop motivation is Self-Determination Theory (SDT) (Ryan & Deci, 2020). It focuses on "people's inherent motivational

propensities for learning and growing" (Ryan & Deci, 2020, p.1). However, the willingness to learn cannot be considered in isolation from external conditions (Ryan & Deci, 2020). Instead, the social environment influences to what degree people engage in activities and what people learn (Ryan & Deci, 2000a).

From a SDT perspective, learning support measures and tools need to consider three basic psychological needs (autonomy, competence, relatedness) to achieve not only immediate but longer-term, sustained motivational effects (Ryan & Deci, 2000a, 2020). Although SDT has been applied to various domains of life (Chen et al., 2015; Ryan & Deci, 2020; Vansteenkiste et al., 2010) and also in the context of older adults (Dupuy et al., 2016; Vallerand & O'Connor, 1989) there are to our knowledge no studies that allow in-depth insights into the effects of a learning session, considering all basic needs onto the engagement with interactive digital technology among older adults over a longer time period.

In the present study, we examine how older adults can be supported in developing a sustained motivation to engage with digital technologies. We focus on identifying potential individual impact factors that need to be considered when assessing the effects of learning support measures in this field. The application of SDT in this field should contribute to both, development of theory and effective support methods.

Specifically, we aim to examine.

- Older people's motivational pathways (i.e., change of motivation over time and the determinants influencing this change) the when engaging with timely interactive digital technologies and
- Individual impact factors influencing sustained behavioural and attitudinal changes subsequently to the participation in a SDT-informed learning session.

For reaching that aim, we conducted a qualitative longitudinal study with 33 people between 60 and 88 years old, who participated in a game-based learning session that was designed considering the psychological needs of SDT. In this paper, we report on the design of the learning session and describe our empirical analyses of the qualitative data on the experiences made in testing this setting in practice.

In the following section, we give an overview on the design of the learning session and introduce SDT as the theoretical background of the present study. In Sect. 3 we describe the methodology of the study before presenting the findings in Sect. 4, followed by a discussion of the implications of the results.

## 2 The Learning Session

This section describes the design of a SDT-informed learning session, which was first described in Oppl (2022), and provides the foundation for the present study. Before that, we introduce SDT as the theoretical framework underlying the entire research process.

### 2.1 Background: Self-Determination Theory (SDT)

SDT describes different types and qualities of motivation: *Intrinsic motivation* represents the highest level of self-determined (autonomous) behavior (Ryan & Deci, 2000a) because "people understand the activity to be something they want to do for its own sake" (Deci & Ryan, 1985, p. 57). Hence, it is triggered by individual interest or fun (Ryan & Deci,

2000b) and associated with well-being and high-quality performance (Ryan & Deci, 2017; Taylor et al., 2014). In contrast, *extrinsically motivated* behavior is shown by people "in order to attain some separable outcome" (Ryan & Deci, 2000a, p.71) without experiencing inherent satisfaction (Deci & Ryan, 1987). However, acting to achieve a separable outcome does not necessarily go along with a feeling of being externally controlled (Deci & Ryan, 1985; Ryan & Deci, 2000a). The perceived self-determination depends on the degree of the internalization of values underlying the behavior (Ryan & Deci, 2020). How far people internalize the values underlying a behavior depends on the satisfaction of their psychological needs (Ryan & Deci, 2020), which can be fostered or inhibited through the social environment (Moller et al., 2006). SDT describes three basic psychological needs that are essential for all humans "across individual and cultural differences" (Chen et al., 2015, p. 233):

The need for **competence** describes that people want to perform activities that optimally meet their abilities. However, it is "not an attained skill or capability, but rather is a felt sense of confidence and effectance in action" (Deci & Ryan, 2002, p. 7). People need to feel that they can successfully accomplish their tasks (Ryan & Deci, 2020). The social environment can facilitate the feeling of competence through "well-structured environments that afford optimal *challenges, positive feedback, and opportunities for growth*." (Ryan & Deci, 2020, p. 1).

The need for **autonomy** describes that people want to perceive the causation of action in themselves (Ryan & Deci, 2020). The "term autonomy" refers to "self-governance" and does not imply "that people's behavior is determined independently of influences from the social environment" (Ryan & Deci, 2000a, 2000b, p. 330). Opportunities of choices can facilitate the feeling of autonomy. However, *choices* can only have positive effects when they are attributed personal significance. If people don't perceive the available tasks or activities as personally relevant, they won't experience any autonomy support (Moller et al., 2006).

**Relatedness** is the third basic need and describes that people want to belong to others. It also represents the desire to be supported, accepted, and to be a part of a community with shared interests and values (Deci & Ryan, 2002). People need good reasons to act when they do not experience inherent satisfaction. One such reason is feeling related to other people that appreciate an activity or behavior. The social environment can facilitate this psychological need "by conveyance of *respect and caring*" (Ryan & Deci, 2020, p. 1). This includes the overall social setting in which technology use is embedded in and which it should support, as well as in-situ support in case of problems with technology use and/or learning to use it. In either scenario relatedness is linked to building a sense of belonging and mutual trust, which needs to be established among the involved persons.

Digital technology is often not used due to intrinsic motivation, especially by older adults (Friemel, 2016). It rather represents an external affordance, which has become necessary for many areas of life (Chiu & Liu, 2017). Hence, aiming to support the skilled and self-determined use of digital technology requires the consideration of the basic psychological needs (Ryan & Deci, 2000a).

### 2.2 Design of the Learning Session

The learning session aims to support the basic psychological needs of older adults while they gain their first experiences with a tablet computer. Thereby, the session was designed to incorporate important educational elements and principles. The participation in the

learning session should foster the engagement with digital devices (e.g., smartphones, tablets) in everyday life (Oppl, 2022).

The learning session is conceptualized based on experiential learning according to Kolb (1984) and applies a *game-based learning* approach using entertainment games on tablets. Studies show positive motivational effects of games in learning sessions (Connolly et al., 2012; Sung et al., 2017). Furthermore, previous studies indicate that playing entertainment games (e.g., puzzles, memory, sudoku) allows positive first experiences with tablets for older adults and positive effects on the engagement with touchscreen-based technologies (Oppl, 2020; Springett et al., 2018). However, solely relying on the effects of gaming is not sufficient for fostering positive learning experiences. Individualised support (in terms of support adapted to the current needs of the learners) is necessary especially in the beginning of the game-based tasks and when problems occur in the course of interaction (Oppl & Stary, 2020).

In a previous study (Oppl & Stary, 2020), sets of two persons were asked to play together on one tablet with the intention that this setting might encourage them to support each other. However, it turned out that gaming without help from a more experienced facilitator is challenging for early beginners and can lead to frustrating experiences in cases of problems (insufficient satisfaction of the need for competence). The participants tried to seek help from the observing investigator when problems occurred. While participants appreciated the presence of a second novice (need for relatedness), mutual peer help was not always sufficient for enabling successful tablet interactions. Hence, the present learning session is designed for two participants and one facilitator for providing individualised support.

Support adapted to the current needs of the learners can be addressed through *Scaffolding*, a support method that describes how to provide "temporary support […] for the completion of a task that learners otherwise might not be able to complete" (van de Pol et al., 2010, p. 272). Scaffolding is an "interactive process" between a facilitator and a learner "who both participate actively in the process" (van de Pol et al., 2010, p. 274). The learners should work as independently as possible on tasks adapted to the "current level of […] performance." For providing adequate tasks, diagnosis of the previous experiences and the level of competence is needed. The support during the learning experience should be adapted to the needs of the learners and reduced over time aiming to complete the task as independently as possible (van de Pol et al., 2010). Thus, Scaffolding can address all basic needs: The adapted tasks and support should foster successful learning experiences aiming to satisfy the need for competence and relatedness. Furthermore, completing the tasks as independently as possible can support both the need for autonomy and competence. In the learning session, facilitators closely observe the actions a learner takes towards accomplishing a given task. In case of evident confusion or actions that would inhibit task accomplishment, facilitators intervene with the least invasive measure appropriate in the observed situation. This can range from asking guiding questions over hinting at potential resolutions to demonstrating steps to progress further towards task accomplishment. The necessary level of support might vary during the process and thus needs to be adapted accordingly—this dynamic adaption is referred to as "fading" (van de Pol et al., 2010).

Figure 1 visualises the procedure of the game-based learning session with the different elements. While the inner circle describes the activities of the participants (represented by ellipses and referring to the activities described by Kolb (1984) in his work on experiential learning), the outer circle shows the methods used by a facilitator for fostering successful learning experiences. In the inner circle, solid arrows indicate transitions between activities that are designed as part of the learning section. The dashed arrow between

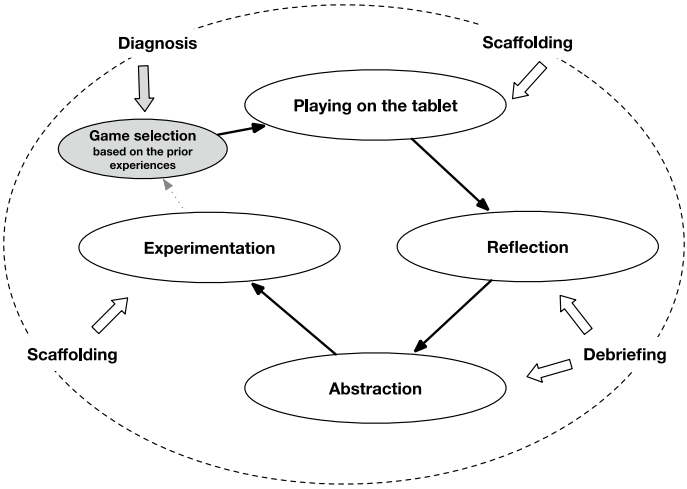


**Fig. 1** SDT-informed learning session (Oppl, 2022)

"Experimentation" and "Game Selection" indicates the option of repeating the learning section with different, e.g., more complex, games. The arrows linking the outer with the inner circle indicate which methods (in the outer circle) are deployed by facilitators in the different activities (in the inner circle).

The following list describes the procedure, and the elements with references to the basic needs are listed in parentheses. The implementation of all design elements by a facilitator should enable the consideration of all psychological needs during the participation (Oppl, 2022):

- Game selection: The participants get a list of different entertainment games for choosing one based on their interests *(autonomy support)*. The list fits the prior experiences with interactive digital technologies identified in a preliminary diagnostic interview *(competence and relatedness support)*. For early beginners, the list consists of simple games that are familiar from experiences in the non-digital world (e.g., Puzzle, Sudoku, Memory).
- Playing on the tablet: Participants play the game as autonomously as possible. However, the facilitator applies *Scaffolding* (van de Pol et al., 2010) as a support method in cases of problems and during the start of the game. The aim is to achieve successful and independent gaming experiences on the tablet without feeling challenged too much or too little *(competence, autonomy and relatedness support)*.
- Reflection & Abstraction: According to Kolb et al. (2018), for transferring the learning experiences to other contexts, learners need to both, reflect on these experiences and draw an abstract conclusion. The facilitator supports the process through *Debriefing* questions based on Walther (2013) which also fulfil a feedback function *(competence and relatedness support)*.
- Experimentation: For applying the prior learning experiences, the participants interact with the tablet again through gaming or experimenting according to their interests *(autonomy support)*. The facilitator assists by applying Scaffolding for fostering successful experiences *(competence and relatedness support)*.

The cycle can be implemented several times in order to be adapted to the needs of the learners.

Facilitators were prepared for their role with respect to two aspects: Methodologically, they were introduced to the fundamental concepts of diagnosing, scaffolding and debriefing and how these concepts could be implemented practically in the specific context. Content-wise, they were asked to get accustomed to and gain practical experiences with the games offered to the participants, in order to be able to support them in case of questions and recognize evident problems via observation of gameplay. A more detailed account on the role and activities of the facilitator in the learning setting is given in (Oppl & Stary, 2020).

## 3 Methodology

The present study followed a longitudinal qualitative approach and took place in the years 2018 and 2019. To recruit participants for the study, we used purposeful sampling, which is a sampling method that sets out to identify and select information-rich cases for the most effective use of limited resources (Palinkas et al., 2015; Patton, 2002). Given the research question, the sample of interest was older adults with little or no experience in the digital domain. 33 participants were recruited through the Association for Elderlies in Upper Austria (Oberösterreichischer Seniorenbund). The association represents a large number of elderly members in retirement age. We called for senior citizens without any or only initial experiences with touchscreen-based technologies in the Association's magazine. More specifically, the inclusion criteria were age (> 60 years) and lack of regular use of digital devices, i.e., either not owning a touchscreen-based digital device (like smartphone or tablet) at all or having little experience and not feeling confident in using it. In line with SDT, the second inclusion criterion was not tied to the objective availability or lack of certain competencies, but the individual perceptions of their own experiences and competencies. All those who volunteered and stated that they met these requirements were invited. Using the selection criterion of self-reported non-confidence—in line with qualitative standards (Levitt et al., 2018)—represents a purposeful decision to focus on a very specific group of individuals who are of theoretical interest for our study. A total of 33 senior citizens aged between 60 and 88 years participated voluntarily and without payment. All of them described themselves as early beginners or inexperienced with touchscreen-based technologies as smartphones or tablets in an initial telephone call. The cohort included 23 women and 10 men. Each of the participants provided informed consent to contribute to our study for the respective processing of data for anonymised presentation.

We describe the collection and analysis of the data in the following two sub-sections. In line with the research question of the paper, the aim of the data collection and analysis was finding out about both people's motivational pathways to engage with interactive digital technologies and individual impact factors influencing sustained motivational changes. Therefore, we needed to investigate (1) the motivation to use digital technology before participating in the learning session, (2) the satisfaction of the basic needs during the participation, and (3) the motivational changes after the participation. The qualitative research approach was necessary to achieve a comprehensive and in-depth understanding of the influences of a SDT-informed learning session and factors influencing the engagement with digital technology in older adults.

### 3.1 Data Collection

Based on the design of the learning session, we invited the participants in pairs. Some of them knew each other as friends or couples, some met for the first time during the session. Older adults may be considered a group more difficult to reach for studies on digital topics than other age groups. For such groups, qualitative research tries to establish research setups that allow for "safety in numbers" (Kitzinger, 1994): "Not only does safety in numbers make some people more likely to consent to participate in the research in the first place ('I wouldn't have come on my own') but being with other people who share similar experiences encourages participants to express, clarify or even to develop particular perspectives" (p.112). The wish of some participants who suggested to come with friends or family members seems to express such a longing for safety in numbers and hence the suggestion was accepted. If participants came on their own, they were paired with another participant who they did not know in advance but who nevertheless shared the experience of feeling unfamiliar with digital devices. This relational setup was intended to make participants feel more comfortable and relaxed, and to establish a sense of relatedness and belonging from the very beginning. Facilitator training took place in the weeks before the survey based on the guidelines of the learning session and involved both social as well as content aspects as described above and in (Oppl, 2022). Two other persons were present at each survey: One was responsible for technical tasks such as audio and video recordings. Additionally, the first author of the paper conducted the interviews and created observation protocols during the learning session to identify critical points in the process (e.g., confusion, experienced events of success, etc.). Video recordings of the overall learning setting and screen recordings of the tablets were made during the interactions to allow for detailed ex-post analysis of the process.

Each encounter started with a semi-structured interview, which aimed to find out about prior experiences with interactive digital technologies (e.g., smartphones, tablets), the attitudes towards such technologies, and the satisfaction of basic needs during prior experiences, if there were any. The interview started with a closed opening question regarding interest in using digital technology to set the overall context. We then used open questions to identify both the current motivation to engage with new technologies and fulfilment of the basic needs. Thereby, the formulation of the questions was inspired by a German-language questionnaire addressing interest and basic needs according to SDT (Wilde et al., 2009). The interview included open questions on.

- Previous experiences and the current use of smartphones or tablets.
- Interest in engaging in devices like smartphones or tablets.
- Perceived competence related to the use of smartphones or tablets.
- Perceived autonomy related to the use of smartphones or tablets.
- Perceived pressure related to the use of smartphones or tablets.
- Perceived relatedness / availably and quality of support.

After finishing the interviews, the facilitator carried out the learning session according to the design guidelines. The implementation took about 30 min. The first author conducted observations with a focus on expressions of the fulfilment of psychological needs, fun, and interest during the participation. This included taking notes about successes and failures when interacting with the tablet in an observation protocol. After the learning session, the first author conducted an interview with each participant. To avoid

biases in the answers, the participants were interviewed separately. The semi-structured interview was similar to the initial interview described above. However, instead of addressing using digital technology in general, the questions focused on the experiences made during the participation in the learning session. The aim was to find out about the satisfaction of the basic needs, fun, and interest during the learning session.

Around three months after the participation, we conducted a further semi-structured telephone interview with each participant. This telephone interview aimed to investigate sustained motivational changes in relation to interactive digital technologies triggered by participation. Furthermore, we explicitly assessed potential attitudinal and behavioural changes and asked about the interest in dealing with such digital devices to be able to make a comparison with the situation before participation.

### 3.2 Data Analysis

The data analysis was carried out in two steps:

The first step was based on two Thematic Analyses as described by Braun and Clarke (2006). Thematic Analysis as a qualitative analysis method is suitable for investigating people's experiences and perspectives in-depth. In line with the method, which allows for both inductive and deductive procedures (Braun & Clarke, 2006), we adopted a two-stage process: First, we used SDT as an analytic framework for investigating the satisfaction of basic needs in a deductive analysis. For preparing the data, all interviews, the video recordings of the learning sessions as well as the observation protocols created during these sessions were transcribed in full. In line with Braun and Clarke's (2006) procedure description, the themes were determined a-priori based on SDT as a theoretical framework ("autonomy", "competency", "relatedness"). These themes were then used for coding the fully transcribed interview data (e.g., code "not able to autonomously use one's own mobile device" was used to code instances of interview quotes indicating negative perceptions of the theme "autonomy", such as (translated from German) "I would be interested in really using my device, but whenever I try, I fail and then need my children's support—which is annoying for me as well as for them".). The comprehensive code book and the coded raw data is available as an open dataset on Zenodo.[1]

Second, we identified observable changes in motivation, behaviour or attitude in an inductive analysis approach (i.e., without a pre-defined analytical framework). The combination of interview and observational data allowed for a comprehensive picture on the satisfaction of basic needs during participation. A prominent example for a theme that could be identified inductively is the role of scaffolding during the gameplay and experimentation phases in the learning sessions. Examples for this theme and further identified topics can be found in Sect. 4.2.

The second step of data analysis was based on typology development as proposed by Kuckartz (2016). We used the procedure proposed by Kuckartz (2016) to conduct a further analysis of the transcribed data to identify potential individual influence factors and needs that affect the impact of the learning support measures. More specifically, we analysed the themes identified in the first step with the aim of developing a typology of different

[1] Oppl, (2023). Dataset for study "The power of a human bridge: motivating older adults to long-term engagement with touchscreen devices in a SDT-based learning session" [Data set]. Zenodo. https://doi.org/10.5281/zenodo.10374027

participant characteristics. A type-based presentation of the research results allows identifying similarities and differences between the cases (Kuckartz, 2016). The generation of the typology enabled analysing the motivational changes in engagement with digital technology based on individual impact factors beyond the basic need satisfaction during the participation. The identified types and examples for the delineating themes are described comprehensively in Sect. 4.4.

## 4 Findings

The data analysis led to the identification of several themes related to (1) the motivation to engage with digital technologies (especially smartphones, tablets) before the participation in the learning session, (2) the satisfaction of the basic needs during the participation, and (3) the behavioural and attitudinal changes three months after the participation. We detail the results for the three aspects in the following sections and thereby illustrate different pathways of motivational change. The resulting typology identifies factors that explain whether or not participation in the learning session results in sustained impact and in an increased engagement with new digital technologies over time.

As described above, the purposeful sampling strategy (Palinkas et al., 2015; Patton, 2002) reached out to address older people without or with very limited prior experience with touchscreen-based technologies and not feeling competent with using digital devices. Actual experience or already existing competence was not included as an inclusion criterion. All of the 33 individuals who volunteered to participate in the learning experience indicated in the beginning to feel completely or largely inexperienced in dealing with digital devices. As such, the sampling procedure reached participants that were of theoretical interest for the study (Levitt et al., 2018). Figure 2 depicts important steps in data collection and analysis of the longitudinal qualitative research design and gives an overview of different pathways of motivational change concerning the engagement with new digital technologies. The uppermost part of the figure delineates the motivational starting point of the participants; it allows to differentiate between those (inexperienced) participants who described themselves as motivated to engage with smartphones or tablets already in the beginning and those who did not. Given that participants needed to show personal initiative by responding to the call for participation, one might assume that overall participants in the sample could be more motivated to engage with digital technology than many of their peers. However, as the interviews showed, the sample also included participants who did not actively volunteer for participation but who were registered by others, such as family or friends.

In addition to the expression of subjectively felt motivation, Fig. 2 also considers a more objective criterion, which details whether the participants already were in possession of a device before participating in the learning session or not. In combination with prior motivation this allows to distinguish between different groups. Among those who were not motivated some already possessed a digital device while others did not. There was less variation among those who expressed motivation before-hand: all of the participants in the sample, who indicated to be motivated, already possessed a device prior to participation. In principle it is thinkable that there is another group, not reached by the sampling strategy, consisting of motivated individuals who do not possess a device (e.g. because they cannot afford it or have not yet purchased a device). This group was not reached in this research. The final distinction in Fig. 2, shown in

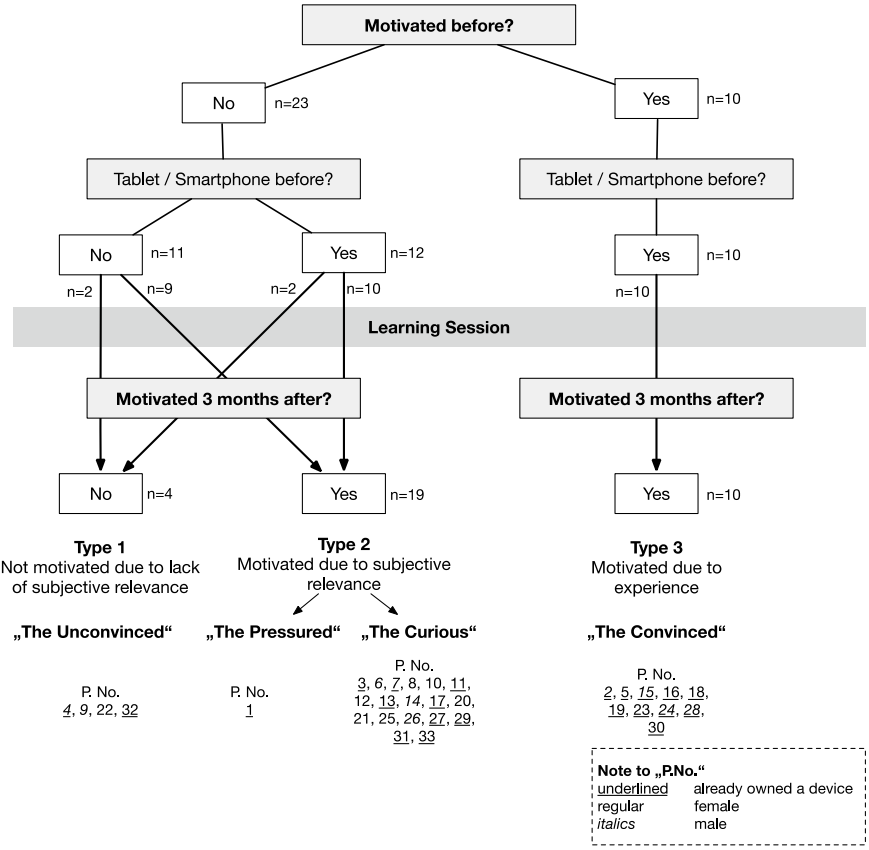


**Fig. 2** Pathways of motivational change and stability

the lowermost part, is based on the assessment of motivation three months after participating in the SDT-informed learning session. Each participant can be assigned to one of the pathways of motivational change as depicted in Fig. 2.

The numbers of participants presented in Fig. 2 next to each branch in the pathway reflect the dynamics of motivational change in the sample but should be interpreted with caution as the research is qualitative in nature and does not claim to be representative of elderly people in general. One objective of our research is an empirically grounded distinction of different types of sustained motivational change, which can be linked to different needs and characteristics of those concerned. What is the impact of participating in a SDT-informed learning session on sustained motivation for elderly people? When presenting the results to this question in the following, we illustrate the claims by quotations from the interviews. Thereby, participants are represented by numbers (Participant Number = Pxy) to ensure the anonymous representation and an unambiguous allocation of the data ("P" … participant, "I" … interviewer). Since the interviews were held in German, the quotations were translated as literally as possible.

### 4.1 Motivation Prior to Participation

The sample consisted of 33 elderly men and women who described themselves as completely or mostly inexperienced with interactive digital technologies. In a next step it was of interest to determine to what degree these participants *wanted* to engage with digital technology at all, that is, how motivated they felt before participation in the learning session. While about one third of the participants indicated to be "motivated", two thirds indicated that they were not, which in the current context means that they stated to be not interested in using interactive digital devices in their daily lives and/or that they felt that their basic needs were not satisfied (e.g., "I am too old to be able to learn how to use it"—perceived lack of competence).

Importantly, there was little overlap of the subjective expression of interest with the actual possession of an interactive digital device, which might be interpreted as a more objective manifestation of interest. 22 out of the 33 participants already owned a device before participating in the learning session. All participants who indicated in the beginning to be subjectively motivated to use the technology in their daily lives, were already in possession of a device. Out of the 23 participants who said that they would not be motivated, about half (11 participants) did not own a smartphone or tablet. The other half, however, was not motivated despite owning a device. The interviews highlighted that the reasons and ways of acquiring such devices are manifold. While some participants bought a device based on their own initiative and without external affordances (e.g., P3, P16), others came into the possession less willingly. Several participants reported that they received a device as a present or that family members had a strong influence on the purchase (e.g., P4, P14, P18). Others experienced pressure to use such devices due to external events. P1, for example, inherited the smartphone of her deceased husband who had taken care of all the couple's digital matters. Thus, his death forced her to cope on her own, although on principle she was not interested in engaging with the device. Other participants reported to have won a tablet in a lottery (P32) or to have bought a smartphone upon recommendation by a shop assistant (P13). Possession of a device hence often was not self-determined.

As already mentioned, all those in the sample who self-described as motivated prior to the learning session already possessed a device before participation. Thereby, some reported on motivational change and development before responding to the call for participation. P15, for example, reported on an initial pressure of family members to buy a digital device, but over time he had become engaged with the device in a self-determined way, which then was visible at the time of participation. He showed great interest and enjoyed using it. Thus, he could be characterized as being motivated already before participation (despite still labelling himself a digital beginner). P4, in contrast, who like P15 had acquired a device upon family pressures—never developed any enthusiasm for the device and hence was characterized as being "not motivated" at the time of the learning experience. He used the smartphone just to make phone calls and felt overwhelmed by the additional functions of the device, which he felt unable to use.

Overall, the sample covered a broad range of participants differing with regard to their initial motivation and contact with digital devices. To what degree could such different groups (and particularly those indicating to be hardly interested) be reached via a game-based learning session designed to address the basic human needs of competence, relatedness and autonomy? And to what degree would such an experience result in long-term motivational change?

## 4.2 Motivation and Need Satisfaction During Participation in the Learning Session

The interview and observation data collected during and immediately after participation gave a comprehensive picture with regard to need satisfaction, fun, and interest experienced in the learning session designed in consideration of game-based learning and principles of self-determination theory. All interviews were conducted in the absence of the facilitator to avoid participants holding back negative feedback out of politeness. Nevertheless, the participants' overall evaluation of the learning session was uniformly positive; all participants reported that it was good fun and an interesting experience for them. In the following analysis, more detailed insights with regard to the design elements are presented.

### 4.2.1 Game-Based Learning

We observed fun and joy during gaming, especially after successfully mastering a game round. In such situations, the participants smiled, laughed, or spontaneously showed other expressions of joy ("great"; "I have made it"). The interviews also indicated explicit openness towards the game-based approach:

P8: "It is nice to learn how to deal with such devices through games."
P25: "It is the right way to learn new things through games."
P26: "It is the same with kids. Starting with games before it becomes more concrete. It is funny."

However, some participants, indicated a preference for a learning session without games as the following quotations show:

P12: "Learning without games would be more interesting for me. I would like to know what else I can do with such devices."
P2: "I would prefer a little more focus on the problems with the own device."
P28: "Everything was fine and pleasant. However, games are not my world."

When it comes to the satisfaction of the basic needs as suggested by self-determination theory, the interview and observation data indicate varying levels of fulfilment while interacting with the tablets as detailed in the following paragraphs.

### 4.2.2 The Need of Relatedness

A particularly consistent picture emerged with respect to the need for relatedness: The interviews and observations revealed that this need was satisfied for all participants except for P26, a 62-year-old man who experienced a lot of difficulties during gaming. The facilitator did not give support in the final part of the game, because she did not realize that the participant needed help. The facilitator thought that the participant wanted to solve the problems on his own because he did not actively seek help. However, the interview showed the opposite: P26 had expected more support and felt left alone. Apart from this single case of inadequate implementation of the scaffolding approach, all other participants were satisfied with the support provided by the facilitator. The following quotations from the interviews illustrate that the satisfaction of a need for relatedness, implemented by successful scaffolding, is crucial for positive learning experiences and wellbeing:

P1: "The facilitator contributed to a very relaxed atmosphere. […] It was very important that someone was there and gave assistance."
P6: "It was very important that someone helped in cases of problems."
P10: "The assistance enabled to cope with the tasks independently afterwards. […] It was very reassuring to have a facilitator by my side."
P32: "It was necessary that the facilitator gave support […] I would be lost on my own."

Aside the sense of relatedness with the facilitator that emerged ad-hoc in cases of successful scaffolding, the sense for relatedness could also be instilled via learning settings, in which learners had a prior relationship (e.g., being significant others or friends) and trusted each other. Such settings of mutual trust appeared to make the participants more resilient to problems and thus compensate for a lacking sense of competence:

P14: „It was great that there were the two of us."
P2: "The presence of a second person was beneficial for my wellbeing. It was very positive, that we were playing in such a small group."
P15: "Yes, this was very important – it gives a feeling of security and builds trust. I'm happy that I have already progressed this far [laughing]".

#### 4.2.3 The Need of Competence

Successful gaming experiences and the presence of a facilitator supported feeling competent, which manifested in statements like: *"I can learn it after all"* (P12). We observed numerous successful tablet interactions that filled the participants with joy (indicated through laughing, smiling, positive statements). The interviews also highlight references to experiences of competence and mastery:

P1: "I am very satisfied (laughing), yes, very. It was very helpful. I think, I'm now more confident in using my smartphone."
P32: "After help from the facilitator, it worked better."

However, a few participants had problems in completing the tasks independently and needed comprehensive support. Hence, although we can assume that the need for competence was satisfied in many cases, we also observed more challenging situations. A few participants explicitly indicated a lack of felt competence in the interview following the learning experience:

P24: "The game was too difficult."
P33: "I have too little experience, so the game was too difficult for me."

It should be noted though that experienced difficulties are not necessarily equal to a lack of need satisfaction. A number of participants (P6, P9, P12, P26) experienced problems and an intensive need for support during gaming, as documented by observation, but nevertheless expressed satisfaction and a feeling of competence later in the interview:

P6: "I had a feeling of success."
P9: "I'm reasonably satisfied with my performance"

Overcoming difficulties (even with the help of the facilitator) hence can represent a highly satisfying experience.

#### 4.2.4 The Need of Autonomy

Many of the participants rated the possibility of choosing a game according to their own preferences positively:

P6: "It is important to have the possibility of choices."
P9: "I prefer choosing the tasks myself."

For some others, choices did not have much meaning:

P14: "I would not have cared if I had not had freedom of choice."

Thus, the possibility to independently choose a task supported the need for autonomy, especially for those participants with preferences for choices.

In summary, the analyses suggest that the presence of a facilitator is the basis to achieve the satisfaction of basic needs during the learning experience: We observed successful tablet interactions when scaffolding was implemented adequately. All participants highlighted the importance of support and care provided by the facilitator for completing the tasks successfully and for feeling comfortable. Hence, relatedness seems to be a prerequisite for this target group before a sense of competence can emerge. Care and support enable positive overall experiences even when problems in dealing with the tablet arise. Adequate support often went along with successful tablet interaction and, subsequently, increased feelings of competence. The interview and observation data indicate that autonomy was less important to the learners than relatedness and competence, especially in the beginning. However, when successful learning experiences made participants more self-confident, they tended to enjoy more and more interactions autonomously over time. Observations showed that competence emerged through relatedness when a facilitator provided individualised support (adapted to the current needs of the learners). Autonomous interaction, in turn, was achieved when the learners felt sufficiently competent to interact with the device on their own.

### 4.3 Motivation 3 Months After Participation

While there were considerable differences in the backgrounds and motivational starting points of the participants, there were (surprisingly) little variation in terms of experiences reported and observed during the learning episode. Most of the participants enjoyed the experience and described the learning experience in a manner that reflected need satisfaction. But how lasting would the positive experience be and would it result in sustained changes in motivation? To consider this question, three months after participating in the SDT-informed learning session, we conducted telephone interviews to identify behavioral and attitudinal changes concerning the engagement with interactive digital devices. Participants had to report on positive shifts in attitudes or behavior to be classified as motivated. Hence, "motivated" in this context is operationalized by statements that show that participation in the learning session triggered either.

- The acquisition of a device.
- The participation in further learning sessions, or
- The expression of increased interest in/openness towards using touchscreen-based technologies in the near future, or
- The expression of better need satisfaction, such as an increased (feeling of) competence or a more self-determined use of an interactive digital device.

P10, for example, reported that her interest in buying a smartphone had increased to a degree that she currently was looking for a good offer in advertising brochures. Similarly, P12 told us that she had started using the tablet and smartphone of her daughter regularly to gain more experience before buying a device of her own. The reported behaviors mirror clear instances of a motivational shift.

The lower part of Fig. 2 depicts different pathways of motivational change, or stability respectively. Before turning to a more in-depth discussion of these developments over time, we want to summarize a further insight from the telephone interviews, where participants were invited to look back upon their experiences during the learning session and share their evaluations, impressions and memories. What participants considered particularly noteworthy were instances of a satisfied need of relatedness, which enabled feelings of competence. They highlighted the pleasant atmosphere as well as the support and care they experienced in the context of a positive learning situation. Hence, data from the telephone interviews support the finding of the importance of feeling related when elderly people have their first experiences with new technologies.

### 4.4 Pathways of Motivational Stability and Change Over Time—A Typology

Figure 2 illustrates the motivational pathways as observed in the sample over time. Following the procedure of Kuckartz (2016), we identified different types and subtypes of development and in the following we discuss them in detail. Thereby, we address an additional factor interacting with basic need satisfaction during the learning experience in affecting long-term motivation. Neither need satisfaction nor already having owned a device earlier provides a complete explanation of whether a long-term change in motivation occurred. The possession of a device does not necessarily increase the motivation to engage with it, and the basic psychological needs were fulfilled during tablet interaction for virtually all participants. The data show that participants of all types can have positive experiences with an interactive digital technology during a SDT-informed learning session. However, the sustained effect depends on a further type-specific individual factor, namely the perception of subjective significance of the technology's use in one's daily life.

**Type 1** ("The Unconvinced") perceives no need to use digital technologies. Participation in the learning session is sometimes based on curiosity to get a first impression of the new technologies, but in other cases is due to pressure of relatives or friends. While participation in the learning session mostly is evaluated positively, it does not influence the subsequent engagement with digital technologies in a sustained way due to a lack of perceived subjective relevance. P9 (male, 76-year-old) is an example for Type 1: he owns a mobile phone without a touchscreen explicitly designed for seniors. He also has a computer. Despite positive experiences during the learning experience *("I'm reasonably satisfied with my performance")*, he is not interested in any other new technologies as the following quotation shows:

P9: "I will never use a smartphone."
I: "Why?"
P9: "Because I don't want to […]. I don't want to learn anything new. […] I don't need it."

P9 is not willing to invest time in learning to operate interactive digital devices; he sees no added value for him and so is not further interested. Similarly, P22 explains that participation was very funny and that she would be willing to participate again, but also that she simply is not interested in technology. Another participant of this type (P4) justifies his lack of interest with reference to feeling pushed towards using a smartphone, which was the wish of family members but not his own.

**Type 2** is willing to engage with digital technologies because of perceived subjective relevance, but has not yet made many experiences in this field. The reasons for the perceived subjective relevance, however, can differ.

**Type 2a** ("The Pressured") perceives an immediate need to use digital technologies based on external circumstances. Using a tablet or smartphone is unavoidable and leads to an urgent pressure to deal with it. Participants of this type are not genuinely interested and had hardly any contact with touchscreen-based technologies. In cases of prior experiences, basic needs remained unmet. Due to the experience of an immediate need, the learning session can influence the motivation to use digital technologies positively. P1 (female, 79-year-old), after the death of her husband, feels pressured to learn how to handle the smartphone. She has no prior experiences because her husband used to take care of all matters that required engaging with a digital device. Since his death she needs to manage all tasks on her own. The following extraction of the interview illustrates the characteristics of type 2a who initially showed little interest:

P1: "Either I'm too stupid or too old to learn it."
I: "Are you interested in smartphones?"
P1: "No, it is just necessary [to use them]."

For P1 the learning session constituted a positive experience that in combination with the perceived personal relevance for her life, caused a shift in motivation:

P1: "The young man (facilitator) motivated me. […] Everything works better with the smartphone now."

P1 highlighted a more self-confident and motivated use of her smartphone in the telephone interview. Three months after the learning session, she was able to use more functions without assistance. While P1 represented a minority within the sample, it is very likely that this type is rather frequent in society. Besides private experiences, such as the death of a partner, collective experiences such as the Covid-19 pandemic can cause an immediate (initially unwelcome) need to deal with the technology. Low-threshold support seems to be particularly valuable in such situations.

**Type 2b** ("The Curious") experiences no immediate need for using digital technology but is aware of potential benefits for everyday life. Participants of this type show initial interest in new technologies because of their potential importance in future. There is no or little prior experience with touchscreen-based technologies. In cases of first prior experiences, basic needs were largely unmet. Due to the awareness of potential benefits, the learning session can positively influence the motivation to use digital technologies. P12 (female, 84-year-old) owned a mobile phone without internet connection and touchscreen. She, however, was aware of a potential added value of using more advanced digital devices

and highlighted her wish to communicate with her grandchild living abroad via the internet. As such, she stated moderate interest in smartphones or tablets, although she saw no immediate need to use a smartphone or tablet before participating in the learning session:

P12: "In principle, I do not need it."

In the learning session P12 came into contact with the technology in a satisfying way:

P12: "I was shown how to use these devices so well here that I might buy one in the future. […] I felt well when getting support."

As a consequence, three months after the learning experience, P12 reported to regularly practice and use the tablet and smartphone of her daughter; she also planned to eventually buy such a device of her own.

**Type 3** ("The Convinced") already has made first experiences with using digital technologies beforehand. Individuals of this type regularly use at least some functions of a tablet or smartphone in a self-determined way. There is comparatively high interest in technology and awareness of its usefulness, due to personal and relevant experiences using digital devices. Not all basic needs were sufficiently satisfied in prior contacts with the technology (e.g., need for relatedness: family members are not always available when problems occur; or need for competence: new challenges lead to uncertainty). The learning session stabilises the motivation to engage with digital technologies and strengthens the already self-determined use of several functions of a smartphone or tablet. P15 (male, 80-year-old) illustrates the characteristic of this type. He used several functions of his smartphone and tablet independently and regularly, even before participating in the learning session. Nevertheless, he described himself as a beginner and thus not very competent in using the devices when registering to participate. Originally, he had started using the device upon family pressures but over time had developed a more autonomous, self-determined use. For him, participation allowed for a reassuring experience and at the end, he felt encouraged and proud:

P15: "I'm glad that I'm more advanced than others of my generation."

In summary, longer-term, sustained changes in motivation triggered through a SDT-informed learning session depend on the degree to which participants experience a personal relevance of using the technology in their daily lives. Type 1 experiences no sustained changes in motivation because of a lack of perceived relevance. Individuals of type 2 experience positive and enduring changes, although for different reasons (immediate need for type 2a vs. perceived potential for type 2b). Importantly, the examples told by the participants of this type once more refer to the important role of a need for relatedness: when mastering a digital device allows connecting to significant others (such as family members abroad) or to engage with society more generally, thereby strengthening a sense of belonging, this can constitute a motivation for change. Type 3 is already interested and motivated when participating although basic needs might not be fully satisfied (or reported as such). The participation preserves and stabilises the existing motivation without fundamental changes in such cases. A lack of change in this group hence is a good sign as it suggests continued and even strengthened motivation. Importantly no individual in this group lost interest or showed reduced motivation after participation in the learning session.

## 5 Discussion

We investigated the influence of a SDT-informed learning session on the longer-term motivation of older adults to engage with interactive digital technological devices. In the following, we discuss the findings with respect to two major aspects that emerged in our study: the effects of the design elements of the learning session (as described in Sect. 2.2) and the individual factors influencing the motivational changes to engage with digital technologies.

### 5.1 Discussion of the Design Elements in the Learning Session

Our investigations show that the game-based learning session reported by Oppl (2022) successfully enables the fulfilment of basic psychological needs as described by Ryan and Deci (2020) during participation. Overall, the present findings also are coherent with literature describing an openness of older adults to digital games (Kaufman et al., 2014; Wang et al., 2011), although some participants stated that they were not interested in games. From a SDT-perspective, a learning session with the option of participating without playing games could be preferred by parts of the target group, thereby addressing the need for autonomy and the interests of individuals lacking gaming affinity. Although the present study confirms that gaming is an appropriate method, we assume that this design element could also be supplemented or replaced according to the preferences of the participants. However, it is not always easy to recognise an individual's gaming affinity: Several participants showed reservations about the game-based learning approach in the beginning. After a while, they changed their point of view and showed joy in playing. However, a few did not develop enthusiasm for playing.

In most cases, playing games led to successful experiences with the tablet because of the successful implementation of a scaffolding approach (van de Pol et al., 2010): Nearly all participants highlighted well-being during participation because of such individual support, feedback, and care of the facilitator. These aspects had a positive impact on satisfying the need for relatedness. Data indicate that individualised support was crucial to foster both the feeling of relatedness and competence. Additionally, being given tasks that corresponded to previous experiences were crucial for successful experiences, which is also in line with SDT (Deci & Ryan, 1985). Scaffolding facilitated users or participants to engage in aligned or demonstrable tasks, based on the diagnosis of participant's current competence. Van de Pol et al. (2010) describe diagnosis as an essential component of scaffolding: "[…] one must first determine the student's current level of competence. Only with such knowledge can the support to be provided be adapted to the student's level of learning […]." Furthermore, scaffolding enabled an autonomy-supportive environment because the facilitator could recognise the participant's preferences and needs allowing independent interaction. Autonomous tablet interactions usually followed successful learning experiences as a result of individualised support.

Based on the observation and interview data of the present study, we hypothesize that feeling related was the decisive factor for the well-being of the participants. Not fully meeting the need of competence (because of difficulties when interacting with the tablet) or autonomy (e.g., because of lacking playing affinity) could be compensated through an ad-hoc sense of relatedness with the facilitator or with peers. Relatedness thus mitigated deficiencies in perceived competence or autonomy, so that these deficiencies did not have much influence on the overall evaluation of participation. However,

from our experience, the relationship with a facilitator should not be considered easily replaceable by relatedness among peers. A facilitator's task is to recognize dissatisfaction and react adequately, which in turn supports participants to gradually move into the community of users. Such supportive behaviour, by both, facilitators or co-learners, and collaboratively trying to solve problems fosters satisfaction of the need for relatedness which appears to act as a catalyst for satisfying the other basic needs: Feeling related triggered through care and recognition of individual needs was a prerequisite for positive learning experiences and progress (feeling competent). Feeling competent is in turn relevant for being able to interact with a digital device without external guidance. Thus, the participants moved towards more autonomy when tasks could be completed successfully instead of being autonomous during the whole learning experience. While the participants differed in the perceived importance they put on each of the needs and in the degree to which they experienced their satisfaction, virtually all of them reported on instances of fulfilment.

### 5.2 Discussion of Individual Impact Factors on Sustainable Motivational Changes

The data show that the influence of the learning session on sustained motivational change in the engagement with digital devices could not be explained only in terms of need satisfaction during participation. Hence, it is crucial to differentiate between the motivation during participation and the motivation to engage with digital technologies in daily life in general. The typology described in Sect. 4.2 highlights factors influencing the behavioural and attitudinal changes after participating in a SDT-informed learning session. Type 1 ("The Unconvinced") can experience far-reaching fulfilment of the basic needs when accomplishing the tasks during the learning session. However, the participation does not lead to significant changes because of a lack of perceived subjective relevance of technology use in one's own life. Hence, the learning session does not address the perceived relevance of technology use for type 1. According to the taxonomy of motivation based on Ryan and Deci (2020), type 1 can be described as "amotivated" due to a "lack of value" or "nonrelevance". This raises the question on the extent to which it is possible to reach a person of type 1 with such an intervention. Real-life tasks or use cases could potentially trigger the missing subjective relevance. If other tasks could address the perception of subjective relevance, it would be possible that type 1 needs to be split into two subtypes, distinguishing those people who can be reached via a scaffolded learning session from those who cannot be reached.

In contrast to type 1, type 2 perceives a subjective relevance of digital technology use. They show similar behaviour but can be distinguished in type 2a ("The Pressured") and type 2b ("The Curious"), depending on the reason for the subjective relevance. For both subtypes, participating in a SDT-informed learning session can trigger positive long-term behavioural or attitudinal changes. While type 2a perceives an immediate need or pressure to use new technological devices, type 2b is interested because of expected potential benefits without perceiving an immediate need. Data indicate that the internalization process of the underlying values (Ryan & Deci, 2000b) is more advanced for type 2b than for type 2a, which experiences higher external pressure.

For type 3 ("The Convinced") it is not clear wether the engagement is based on individual interest (intrinsic motivation) or an already concluded internalisation process (extrinsic motivation). According to Deci & Ryan, the distinction between extrinsic and

intrinsic motivation in such cases "is merely a teleological aspect" because both can be experienced as self-determined (Deci & Ryan, 1987). It is important to understand that type 3 is already motivated in a self-determined way. Hence, the participation in the learning session does not have a decisive influence on behaviour or attitude, as is the case for type 2. Data indicate that type 3 individuals participate mainly driven by their interest and/or to find confirmation of own competences.

## 6 Conclusion

The research presented here addresses the challenges that arise from differences in technology use for older generations. Although digital adoption is rising among older adults, engagement in digital technologies in general is less present in this group (Statista, 2019; Stone et al., 2017). Approaches to understand how to support older adults' motivation to engage in new digital technologies by addressing their individual needs have not been reported so far. The present study contributes to closing this gap by investigating how older adults can be supported in developing sustained motivation to engage in digital technologies from a SDT perspective. Specifically, we aimed to identify potential individual impact factors that need to be considered when assessing the effects of learning support measures in this field. We implemented a longitudinal study approach to identify both people's motivational pathways to engage with touchscreen-based technologies and individual impact factors influencing sustained behavioural and attitudinal changes triggered by the participation in a SDT-informed learning session.

The study examined 23 women and 10 men, who volunteered to participate. It might be considered surprising that more women than men registered for the learning session as gender stereotypes commonly attribute less technological interest to women. Our analyses do not allow for easy interpretation of this gender imbalance. Further studies are needed to find out whether this was a peculiarity of the study (e.g., due to gender imbalance in the addressed target group) or whether women generally are more open to participate in such learning sessions. For the latter, different reasons are possible (e.g., less anxiety to expose oneself in such formats, or less perceived advancement in using technologies compared to men) and should be further examined.

The findings show that a game-based learning approach combined with scaffolding as an individualized support method enables basic need satisfaction according to SDT. We found that adaptive and individual support during the whole learning session is essential for facilitating need satisfaction. Specifically, feeling related through care, recognition of individual needs and an atmosphere of collaboratively solving emerging challenges among the participants and the facilitator appears to act as a catalyst for the satisfaction of the need for competence and autonomy. Hence, well-being of older adults in such learning sessions depends especially on satisfying the need for relatedness; facilitators can build a "human bridge" that results in lasting motivational effects. The game-based learning approach is mainly motivating for people with a general gaming affinity. People who refuse games should be given alternative tasks that match their interests. A detailed investigation of non-game-based tasks and their motivational effects should be addressed in future research.

A central finding is that behavioural and attitudinal changes triggered through a SDT-informed learning session potentially depend on type-specific factors. We derived a typology with four different types from our data that describe different pathways of change with regard to sustained technology engagement. Based on the typology, although we cannot

expect positive changes when people don't perceive any subjective relevance of technology use (type 1),, a SDT-informed learning arrangement can lead to significant changes for both people who perceive an immediate need to engage in digital technologies (type 2a) and for people who perceive potential benefits in the future without any immediate need (type 2b). Both types perceive some subjective importance of technology use, which is crucial for changes in behaviour and attitudes. Type 3 is already motivated in a self-determined way before participating in the learning session. For this reason, we cannot expect to observe such fundamental differences as with types 2a and 2b. Data indicate a lasting and often strengthened motivation to engage with digital technologies after participation for type 3.

In summary, the study identified different pathways of motivational change with regard to digital technology use among older adults over time. Thereby, the findings show that basic needs satisfaction during a learning intervention is essential to strengthen older adults' motivation to further engage with new technologies. Although future research is needed to fully understand the processes involved, it is suggested that the need for relatedness has a specific relevance here. Relatedness appears to act as a catalyst for satisfying the need for competence and autonomy and can be addressed through individualized support and care. Importantly, however, basic need satisfaction during the intervention will only trigger longer-term behavioural and attitudinal changes if the technology is perceived as relevant by those concerned. Based on these findings, it is suggested that learning interventions designed for this target group need to address subjective relevance to use digital technologies in everyday life in order to achieve sustained real-world impact. How this can be achieved is beyond the scope of the present study, but should be addressed in further research investigating how older adults can be supported vto appreciate the benefits of technology use.

**Acknowledgements** The authors would like to thank the Oberösterreichischen Seniorenbund and the participants for the cooperation during the study. Furthermore, we would like to thank Sebastian Gruber, Philip Schuster, Alexander Simon, Rebecca Wernig und Sarah Zeiml for their support activities necessary to perform the present study

**Author Contributions** SO: Conceptualization, Methodology, Investigation, Data Curation, Writing—Original Draft, Writing—Review & Editing, Visualization. NK: Methodology, Data Curation, Writing—Review & Editing. CS: Funding acquisition, Writing—Review & Editing. SO: Conceptualization, Writing—Review & Editing.

**Funding** Open access funding provided by Danube University Krems University for Continuing Education. This research was partially funded by the European Union`s Erasmus + Programme Grant no. 2016-1-UK01- KA204-024508.

**Data availability** The datasets generated and analyzed in the course of the present study are available in the Zenodo repository, https://doi.org/10.5281/zenodo.10374027

## Declarations

**Informed consent** Informed consent was obtained from all participants involved in the study prior to the initial interview. All data was stored in an anonymized way to maintain privacy of the involved subjects.

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## References

Barnard, Y., Bradley, M. D., Hodgson, F., & Lloyd, A. D. (2013). Learning to use new technologies by older adults: Perceived difficulties, experimentation behaviour and usability. *Computers in Human Behavior, 29*(4), 1715–1724. https://doi.org/10.1016/j.chb.2013.02.006

Bollin, A., & Micheuz, P. (2018). Computational thinking on the way to a cultural technique. *Open Conference on Computers in Education*, 3–13.

Boudreau, M.-C., & Robey, D. (2005). Enacting integrated information technology: A human agency perspective. *Organization Science, 16*(1), 3–18. https://doi.org/10.1287/orsc.1040.0103

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Charness, N., & Boot, W. R. (2022). A grand challenge for psychology: Reducing the age-related digital divide. *Current Directions in Psychological Science*. https://doi.org/10.1177/09637214211068144

Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van der Kaap-Deeder, J., Duriez, B., Lens, W., Matos, L., Mouratidis, A., et al. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion, 39*(2), 216–236. https://doi.org/10.1007/s11031-014-9450-1

Chiu, C.-J., & Liu, C.-W. (2017). Understanding older adult's technology adoption and withdrawal for elderly care and education: Mixed method analysis from national survey. *Journal of Medical Internet Research*. https://doi.org/10.2196/jmir.7401

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education, 59*(2), 661–686. https://doi.org/10.1016/j.compedu.2012.03.004

Deci, E. L., & Ryan, R. (1985). Intrinsic motivation and self-determination in human behavior. *New York: Plenum.*

Deci, E. L., & Ryan, R. M. (2002). Overview of self-determination theory: An organismic dialectical perspective. *Handbook of self-determination research*, 3–33.

Deci, E. L., & Ryan, R. M. (1987). The support of autonomy and the control of behavior. *Journal of Personality and Social Psychology, 53*(6), 1024.

Delello, J. A., & McWhorter, R. R. (2017). Reducing the digital divide: Connecting older adults to iPad technology. *Journal of Applied Gerontology, 36*(1), 3–28. https://doi.org/10.1177/0733464815589985

Dupuy, L., Consel, C., & Sauzéon, H. (2016). Self determination-based design to achieve acceptance of assisted living technologies for older adults. *Computers in Human Behavior, 65*, 508–521. https://doi.org/10.1016/j.chb.2016.07.042

Eurostat. (2021). *How popular is internet use among older people?* https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/edn-20210517-1

Evangelista, R., Guerrieri, P., & Meliciani, V. (2014). The economic impact of digital technologies in Europe. *Economics of Innovation and New Technology, 23*(8), 802–824. https://doi.org/10.1080/10438599.2014.918438

Fenwick, T., & Edwards, R. (2016). Exploring the impact of digital technologies on professional responsibilities and education. *European Educational Research Journal, 15*(1), 117–131. https://doi.org/10.1177/1474904115608387

Friemel, T. N. (2016). The digital divide has grown old: Determinants of a digital divide among seniors. *New Media & Society, 18*(2), 313–331. https://doi.org/10.1177/1461444814538648

He, J., & Freeman, L. A. (2010). Are men more technology-oriented than women? The role of gender on the development of general computer self-efficacy of college students. *Journal of Information Systems Education, 21*(2), 203–212.

Kaufman, D., Sauvé, L., Renaud, L., Duplàa, E. (2014). Benefits and Barriers of Older Adultsź Digital Gameplay. *Proceedings of the 6th International Conference on Computer Supported Education 1:* 213–219. https://doi.org/10.5220/0004792302130219

Kitzinger, J. (1994). The methodology of Focus Groups: The importance of interaction between research participants. *Sociology of Health & Illness, 16*(1), 103–121.

Kolb, A., Kolb, D., et al. (2018). Eight important things to know about the experiential learning cycle. *Australian Educational Leader, 40*(3), 8.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.

Kuckartz, U. (2016). Typenbildung und typenbildende Inhaltsanalyse in der empirischen Sozialforschung. In M. W. Schnell, C. Schulz, U. Kuckartz, & C. Dunger (Hrsg.), *Junge Menschen sprechen mit sterbenden Menschen* (S. 31–51). https://doi.org/10.1007/978-3-658-12317-8_2

Levitt, H. M., Bamberg, M., Creswell, J. W., Frost, D. M., Josselson, R., & Suárez-Orozco, C. (2018). Journal article reporting standards for qualitative primary, qualitative meta-analytic, and mixed methods research in psychology: The APA Publications and Communications Board task force report. *American Psychologist, 73*(1), 26–46. https://doi.org/10.1037/amp0000151

Ling, R., Fortunati, L., Goggin, G., Lim, S. S., & Li, Y. (2020). *The Oxford Handbook of Mobile Communication and Society*. Oxford University Press.

Moller, A. C., Deci, E. L., & Ryan, R. M. (2006). Choice and ego-depletion: The moderating role of autonomy. *Personality and Social Psychology Bulletin, 32*(8), 1024–1036. https://doi.org/10.1177/0146167206288008

Oberländer, M., Beinicke, A., & Bipp, T. (2020). Digital competencies: A review of the literature and applications in the workplace. *Computers & Education, 146*, 103752. https://doi.org/10.1016/j.compedu.2019.103752

Oppl, S. (2023). Dataset for study "The power of a human bridge: motivating older adults to long-term engagement with touchscreen devices in a SDT-based learning session." Zenodo. https://doi.org/10.5281/zenodo.10374027

Oppl, S., & Stary, C. (2020). Game-playing as an effective learning resource for elderly people: Encouraging experiential adoption of touchscreen technologies. *Universal Access in the Information Society, 19*(2), 295–310. https://doi.org/10.1007/s10209-018-0638-0

Oppl, S. (2020). Touchscreens for All? Angeleitetes Spielen als Einstieg für Senioren und Seniorinnen in digitale Technologien. *HMD Praxis der Wirtschaftsinformatik*, 1–13. https://doi.org/10.1365/s40702-020-00595-x

Oppl, S. (2022). Selbstbestimmte Annäherung an digitale Technologien – ein motivationsorientiertes Unterstützungsinstrument für Senior*innen. In K. Weber & S. Reinheimer (Hrsg.), *Faktor Mensch*. Springer Vieweg.

Pal, D., Triyason, T., & Funikul, S. (2017). Smart homes and quality of life for the elderly: A systematic review. *2017 IEEE International Symposium on Multimedia (ISM)*, 413–419. https://doi.org/10.1109/ISM.2017.83

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health, 42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Patton, M. Q. (2002). *Qualitative research and evaluation methods (3rd edition)*. Sage.

Peters, D., Calvo, R. A., & Ryan, R. M. (2018). Designing for motivation, engagement and wellbeing in digital experience. *Frontiers in Psychology, 9*, 797. https://doi.org/10.3389/fpsyg.2018.00797

Porter, C. E., & Donthu, N. (2006). Using the technology acceptance model to explain how attitudes determine Internet usage: The role of perceived access barriers and demographics. *Journal of Business Research, 59*(9), 999–1007. https://doi.org/10.1016/j.jbusres.2006.06.003

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications.

Ryan, R. M., & Deci, E. L. (2000a). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Ryan, R. M., & Deci, E. L. (2000b). 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., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Schmid, A. M., Recker, J., & Vom Brocke, J. (2017). The socio-technical dimension of inertia in digital transformations. *Proceedings of the 50th Hawaii International Conference on System Sciences*. https://doi.org/10.24251/HICSS.2017.583

Springett, M., Keith, S., & Whitney, G. (2018). Game-based introductory learning: Teaching digital skills to older citizens. *Proceedings of the 32nd International BCS Human Computer Interaction Conference 32*, 1–4.

Statista. (2019). *Anteil der Internetnutzer in Österreich nach Alter n den Jahren 2012 und 2019*. Statista. https://de.statista.com/statistik/daten/studie/184967/umfrage/internet-nutzung-in-oesterreich-nach-alter/

Statistik Austria. (2021). *IKT-Einsatz in Haushalten 2021*.

Stone, M. E., Lin, J., Dannefer, D., & Kelley-Moore, J. A. (2017). The continued eclipse of heterogeneity in gerontological research. *The Journals of Gerontology: Series B, 72*(1), 162–167. https://doi.org/10.1093/geronb/gbv068

Sung, H.-Y., Hwang, G.-J., Lin, C.-J., & Hong, T.-W. (2017). Experiencing the Analects of Confucius: An experiential game-based learning approach to promoting students' motivation and conception of learning. *Computers & Education, 110*, 143–153. https://doi.org/10.1016/j.compedu.2017.03.014

Szabo, A., Allen, J., Stephens, C., & Alpass, F. (2019). Longitudinal analysis of the relationship between purposes of internet use and well-being among older adults. *The Gerontologist, 59*(1), 58–68. https://doi.org/10.1093/geront/gny036

Taylor, G., Jungert, T., Mageau, G. A., Schattke, K., Dedic, H., Rosenfield, S., & Koestner, R. (2014). A self-determination theory approach to predicting school achievement over time: The unique role of intrinsic motivation. *Contemporary Educational Psychology, 39*(4), 342–358. https://doi.org/10.1016/j.cedpsych.2014.08.002

Underwood, J. D. (1997). Breaking the cycle of ignorance: Information technology and the professional development of teachers. In *Information Technology* (S. 155–160). Springer. https://doi.org/10.1007/978-0-387-35081-3_19

Vallerand, R. J., & O'Connor, B. P. (1989). Motivation in the elderly: A theoretical framework and some promising findings. *Canadian Psychology/psychologie Canadienne, 30*(3), 538. https://doi.org/10.1037/h0079828

van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher-student interaction: A decade of research. *Educational Psychology Review, 22*, 271–296. https://doi.org/10.1007/s10648-010-9127-6

Vansteenkiste, M., Niemiec, C. P., & Soenens, B. (2010). *The development of the five mini-theories of self-determination theory: An historical overview, emerging trends, and future directions*. Theoretical perspectives on motivation and achievement. Emerald Group Publishing Limited.

Walther, L. R. F. Z. J. (2013, August 5). *Debriefing Topics and Their Effects on Learning with Computer Games*. http://essay.utwente.nl/64211/1/Walther,_L.R.F.Z.J._-_s0212229_(verslag).pdf

Wang, F., Lockee, B. B., & Burton, J. K. (2011). Computer game-based learning: Perceptions and experiences of senior Chinese adults. *Journal of Educational Technology Systems, 40*(1), 45–58. https://doi.org/10.2190/ET.40.1.e

Wilde, M., Bätz, K., Kovaleva, A., & Urhahne, D. (2009). Überprüfung einer Kurzskala intrinsischer Motivation (KIM). *Zeitschrift für Didaktik der Naturwissenschaften*, *15*. https://pub.uni-bielefeld.de/record/2404161

Wortley, D., An, J.-Y., & Heshmati, A. (2017). Tackling the challenge of the aging society: Detecting and preventing cognitive and physical decline through games and consumer technologies. *Healthcare Informatics Research, 23*(2), 87–93. https://doi.org/10.4258/hir.2017.23.2.87

Yu, T.-K., Lin, M.-L., & Liao, Y.-K. (2017). Understanding factors influencing information communication technology adoption behavior: The moderators of information literacy and digital skills. *Computers in Human Behavior, 71*, 196–208. https://doi.org/10.1016/j.chb.2017.02.005

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