

Faculty of Educational Sciences
University of Helsinki

FLOURISHING IN 21ST CENTURY WORKPLACES

**HOW TO SUPPORT KNOWLEDGE WORKERS'
PRODUCTIVITY AND WELL-BEING IN MODERN
ENVIRONMENTS**

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DOCTORAL DISSERTATION

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ABSTRACT

The rapid development of digital technology and the emergence of increasingly complex and abstract surroundings challenge accustomed work practices and the well-being and productivity of employees. A growing proportion of today's work is knowledge intensive and multi-locational, and at the same time more autonomous and less clearly defined than before. It takes place in complex embedded digital, physical and social surroundings and is increasingly diverse in terms of both time and place. These changes open up unforeseen possibilities and may potentially support both the productivity and well-being of employees. However, if the human perspective and the prerequisites for healthy and effective human functioning are not understood, unintentional practices related to modern environments and digital tools may pose a threat to both productivity and sustainability. Mental overload and stress have become one of the most prevalent health risks worldwide, and developing sustainability strategies for different life domains is crucial. In order to manage psychological resources in ways required by current working life, both individuals and organizations need new strategies and tools that are based on scientific knowledge.

This doctoral dissertation addresses the aforementioned possibilities and challenges created by today's digitally-mediated knowledge work. It focuses in particular on the role of modern knowledge work environments in users' productivity and well-being and aims to produce new knowledge regarding how these environments and tools can best be utilized to support them. The dissertation approaches these questions from the viewpoint of motivational psychology, educational psychology, work and organizational psychology, and occupational health research. The theoretical framework of the dissertation is the self-determination theory, in particular the mini theory of basic psychological needs, which offers a theoretical tool for approaching the phenomena under study.

The general research question of the dissertation was: How can learning, productivity and well-being be supported in modern work and study environments? More specifically, the aims of the substudies were as follows: Study I explored the role of the physical environment with regard to learning from the perspective of basic psychological needs. It also aimed to expand the interactional perspective of the theory of basic psychological needs by considering the role of the physical environment in either supporting or hindering the satisfaction of basic psychological needs. The focus of Study II was both theoretical and pragmatic: it presented a training program that focused on supporting well-being and productivity at work by developing the participants' awareness skills and behavioral strategies related to knowledge work, physical spaces and digital tools. The results of the training were analyzed, and the knowledge gained in the process aimed to not only develop

the training program further but also enhance understanding of the phenomena under study on a more general level. Study III aimed to develop and pilot a scale for assessing multi-locational knowledge workers' self-regulatory skills related to productivity and well-being. In order to start the validation process of the scale, the study also examined its relations with established scales of well-being at work.

The dissertation studies utilized qualitative, quantitative and mixed research methods. In Study I, we conducted semi-structured focus-group interviews, following an interpretivist approach (n = 21) and analyzed them in a data-driven manner with repeated stages of individual and collaborative analysis. Study II utilized a set of univariate analyses of variance (n=189) and phenomenon-driven content analysis of qualitative reports (n=15). In Study III, we used confirmatory factor analysis (CFA), an independent samples t-test, MANOVA and latent variable correlation analyses (n=202). The data consisted of Finnish early-stage university chemistry students (Study I) and of employees of public organizations, SMEs and start-up companies from the Finnish metropolitan area (Study II, III).

Study I concluded that like the social and cultural environment, the physical environment can also support or hinder the satisfaction of basic psychological needs in various ways. The results of Study I demonstrated that the design and functionality of the physical environment plays a significant role in users' intellectual and emotional functioning, and that learning and well-being can be facilitated by developing physical environments that support basic psychological needs. The results of Study II showed that the participants from different organizations had very diverse experiences of how well the environment and tools supported their work, and consequently, diverse needs regarding using multi-locational spaces and digital tools in ways that support productivity and well-being. The organizational culture of each organization was manifested in the way the physical spaces were designed and used, and in the kind of support needs they had. The study concluded that individuals and organizations can benefit from training in the use of modern spaces and tools in ways that support productivity and well-being. Study III showed promising results regarding the use of the scale presented in the study for measuring the self-regulatory skills related to productivity and well-being in multi-locational knowledge work. The measurement model specified according to the theoretical background showed a good fit and the latent variable correlation analyses confirmed expected and meaningful relations between self-regulation factors and the established scales of well-being at work.

This dissertation combined multidisciplinary knowledge and mixed method empirical studies to shed light on the topical questions of how to utilize modern environments and tools to support productivity, well-being and sustainability. It contributes to areas in current research that lacked emphasis: by studying the role of the physical environment in supporting basic psychological needs and motivation; by developing programs for organizations and individuals in order for them to utilize modern

environments and tools to support productivity and well-being; and by developing measurement tools to assess the new competencies required by current working life and knowledge work in particular. The dissertation offers new theoretical input and operationalizes questions of how to assess and support proactive employee functioning in increasingly complex physical, digital and social surroundings. The knowledge produced in this dissertation can also be utilized in the design of new work environments or learning environments or in the renovation of old ones to better support and meet the needs of users.

TIIVISTELMÄ

Muun muassa digitalisaation myötä dramaattisesti muuttuva, moniulotteinen ja abstraktisoituva toimintaympäristö haastaa paitsi työn tekemisen tapoja, myös tuottavuutta ja hyvinvointia uudella tavalla. Kasvava osuus nykypäivän työstä on ominaispiirteiltään tietointensiivistä ja monipaikkaista, ja samaan aikaan itseohjautuvampaa ja epämääräisemmin määriteltyä kuin ennen. Työ tapahtuu kompleksisissa, toisiinsa limittyvissä digitaalisissa, fyysisissä ja sosiaalisissa ympäristöissä ja on sekä ajan että paikan osalta aiempaa monimuotoisempaa. Nämä muutokset avaavat ennen näkemättömiä mahdollisuuksia ja voivat parhaimmillaan tukea sekä työntekijöiden tuottavuutta että hyvinvointia. Ymmärrys tuottavan ja tasapainoisen inhimillisen toiminnan reunaehdoista on kuitenkin ensiarvoisen tärkeää; muussa tapauksessa uusiin ympäristöihin ja digitaalisiin välineisiin liittyvät epätarkoituksenmukaiset käytännöt voivat vaarantaa sekä työntekijöiden tuottavuuden että hyvinvoinnin. Psykkinen ylikuormittuneisuus ja stressi ovat yksi tämän hetken suurimmista maailmanlaajuisista terveysriskeistä, ja nykypäivän yhteiskunnassa tarve kestävästä kehityksestä tukeville strategioille elämän eri osa-alueilla on korostunut. Sekä yksilöt että organisaatiot tarvitsevat uusia tutkimustiedolle pohjautuvia työkaluja ja strategioita hallinnoidakseen psykologisia resursseja tavalla, jota nykypäivän työelämä vaatii.

Tämä väitöskirja tarkastelee edellä mainittuja, nykypäivän digitaalisesti välittyvään tietotyöhön liittyviä mahdollisuuksia ja haasteita. Se keskittyy erityisesti modernien tietotyöympäristöjen rooliin suhteessa käyttäjien tuottavuuteen ja hyvinvointiin, ja pyrkii tuottamaan uutta tietoa siitä, miten kyseisiä ympäristöjä ja niihin liittyviä välineitä voidaan parhaiten hyödyntää tuottavuuden ja hyvinvoinnin tukena. Väitöskirja lähestyy näitä kysymyksiä yhdistäen motivaatiopsykologian, kasvatopsykologian, työ- ja organisaatiopsykologian sekä työhyvinvointitutkimuksen näkökulmia. Tutkimuksen taustateorianä on itsemääräämisteoriat ja erityisesti psykologisten perustarpeiden osateoria, joka tarjoaa teoreettisen työkalun tutkimuksen kohteena olevien ilmiöiden tarkasteluun.

Väitöskirjan kokoava tutkimuskysymys oli: Miten oppimista, tuottavuutta ja hyvinvointia voidaan tukea moderneissa työ- ja oppimisympäristöissä? Osatutkimusten tarkemmat päämäärät olivat seuraavat. Osatutkimus I tarkasteli fyysisen ympäristön roolia oppimisessa psykologisten perustarpeiden näkökulmasta. Se pyrki myös laajentamaan psykologisten perustarpeiden teorian vuorovaikutteista näkökulmaa tarkastelemalla myös fyysisen ympäristön roolia psykologisten perustarpeiden tyydyttymisen tukemisessa tai haastamisessa. Osatutkimuksen II fokus oli sekä teoreettinen että käytäntöön soveltava: se esitteli valmennusohjelman, joka keskittyi hyvinvoinnin ja tuottavuuden tukemiseen työssä kehittämällä osallistujien

tietoisuustaitoja sekä tietotyöhön, fyysisiin tiloihin ja digitaalisiin työvälineisiin liittyviä strategioita. Osatutkimus tarkasteli valmennuksen tuloksia ja pyrki hyödyntämään tätä tietoa ilmiön ymmärtämisessä laajemmin. Osatutkimuksessa III kehitettiin ja pilotoitiin uusi kyselymenetelmä laaja-alaisten tuottavuuteen ja hyvinvointiin liittyvien itsesäätelytaitojen arvioimiseksi monipaikkaisessa tietotyössä. Kyselymittarin validointiprosessin aloittamiseksi osatutkimus myös tarkasteli mittarin suhteita vakiintuneisiin työhyvinvoinnin mittareihin.

Väitöskirjatutkimuksessa hyödynnettiin laadullista, määrällistä sekä monimenetelmällistä tutkimusotetta. Osatutkimuksessa I toteutettiin puolistrukturoidut fokusryhmähaastattelut interpretivistisen lähestymistavan mukaan (n=21). Haastatteluaineisto analysoitiin aineistolähtöisesti, toteuttaen useita yksilöllisiä ja yhteistoiminnallisia analysointivaiheita. Osatutkimuksessa II hyödynnettiin yhden muuttujan varianssianalyysiä (n=189) sekä ilmiölähtöistä laadullisen aineiston sisällönanalyysiä (n=15). Osatutkimuksessa III käytettiin konfirmatorista faktorianalyysiä, riippumattomien otosten t-testiä, monimuuttujaista varianssianalyysiä sekä latenttien muuttujien korrelaatioanalyysiä (n=202). Tutkimusaineisto koostui suomalaisista alkuvaiheen kemian yliopisto-opiskelijoista (osatutkimus I) sekä pääkaupunkiseudun julkisten organisaatioiden, pienten ja keskisuurten yritysten sekä start-up-yritysten työntekijöistä (osatutkimukset I, II).

Osatutkimuksessa I todettiin, että samoin kuin sosiaalinen ja kulttuurinen ympäristö, myös fyysinen ympäristö voi tukea tai haastaa psykologisten perustarpeiden tyydyttymistä monin eri tavoin. Osatutkimuksen tulokset havainnollistavat, että fyysisen ympäristön funktionaalisuudella on merkittävä rooli käyttäjien älyllisessä ja emotionaalisessa toiminnassa, ja että oppimista ja hyvinvointia voidaan tukea kehittämällä fyysisiä ympäristöjä, jotka tukevat psykologisia perustarpeita. Osatutkimuksen II tulokset osoittivat, että eri organisaatioiden työntekijöillä oli hyvin erilaiset kokemukset siitä, miten hyvin työpaikan ympäristö ja välineet tukivat työntekoa, ja vastaavasti monimuotoiset kehitystarpeet liittyen monipaikkaisten ympäristöjen ja digitaalisten välineiden käyttöön tavalla, joka tukee tuottavuutta ja hyvinvointia. Osallistujaorganisaatioiden organisaatiokulttuuri ilmentyi fyysisten tilojen suunnittelussa ja käytössä sekä siinä, millaista niihin liittyvää tukea kussakin organisaatiossa tarvittiin. Johtopäätöksenä todettiin, että yksilöt ja organisaatiot voivat hyötyä koulutuksesta käyttäkseen moderneja tiloja ja välineitä tavalla, joka tukee tuottavuutta ja hyvinvointia. Osatutkimus III esitteli uuden kyselymittarin tuottavuuteen ja hyvinvointiin liittyvien itsesäätelytaitojen arvioimiseksi monipaikkaisessa tietotyössä ja osoitti lupaavia tuloksia sen käyttöön liittyen. Malli sopi aineistoon ja noudatti teoreettisen taustan pohjalta odotettua faktorirakennetta, ja latenttien muuttujien korrelaatioanalyysit vahvistivat odotettuja ja mielekkäitä yhteyksiä itsesäätelyfaktorien ja vakiintuneiden työhyvinvoinnin mittareiden välillä.

Väitöskirjatutkimus tuo tarkasteluun ajankohtaisen kysymyksen siitä, miten uusia ympäristöjä ja välineitä voidaan hyödyntää työn ja hyvinvoinnin tukena. Se yhdistää monitieteistä tutkimustietoa sekä monimenetelmällisiä empiirisiä tutkimuksia. Väitöskirjatutkimus tuottaa uutta tietoa ja käytännön työkaluja liittyen aihepiireihin, joihin ei tähänastisessa tutkimuksessa ole pureuduttu: fyysisen ympäristön rooli psykologisten perustarpeiden ja motivaation tukemisessa; valmennusohjelmien kehittäminen organisaatioille ja yksilöille modernien ympäristöjen ja välineiden hyödyntämiseksi tuottavuuden ja hyvinvoinnin tukena; sekä mittareiden kehittäminen nykyisen työelämän ja tietotyön vaatimien uusien osaamisalueiden arvioimiseksi. Väitöskirjatutkimus tarjoaa uutta teoreettista tutkimustietoa sekä operationalisoi kysymyksiä siitä, miten arvioida ja tukea työntekijöiden proaktiivista toimintaa yhä kompleksisemmissä fyysisissä, digitaalisissa ja sosiaalisissa ympäristöissä. Väitöskirjatutkimuksessa tuotettua tietoa voidaan hyödyntää myös suunniteltaessa uusia työ- tai oppimisympäristöjä tai remontoitaessa vanhoja vastaamaan paremmin käyttäjien tarpeisiin.

ACKNOWLEDGEMENTS

Back in 2012, I was driving in the mountainous roads of Northern Thailand on a motorbike with a close friend. This was a part of a round-the-world trip and a gap year that I had been preparing for for a long time. I remember a conversation that we had which, in retrospect, was a part of a significant pivoting point in my life.

Some of the central topics revolved around why were so few people truly excited about their lives? Why was there so much ill-being in working life? Even though I was puzzled by these profound questions, I was absolutely convinced that there is more to life, and so much more to us human beings.

In addition to living a positively groundbreaking time in my own life and being at an important crossroads, I was also having a massive professional crisis. I had had and come across several adverse experiences in working life and in a professional context, which had led me to deeply question my idealism, faith and even my willingness to continue working in my field. I wanted to do something meaningful in the world, but also to thrive in my own life and remain excited about it.

To cut a long story short, after diverse inquiries and out of many potential paths, I ended up, quite coincidentally, starting work at the Research Group of Educational Psychology at the University of Helsinki. The place seemed to offer potential for meaningful work with interesting phenomena and a nice group of people. There happened to be a position open, but I could only be hired as a PhD researcher. This, considering the circumstances, felt rather intimidating, but professor Kirsti Lonka was welcoming, and we happily agreed that I would just start the work, and we would aim to craft it into something interesting that benefitted both parties and see how it went. I was glad of this openminded approach. Thankfully, once we began, I quickly rediscovered my interest in the intriguing phenomena of my field, became engaged in my work again and embarked on what ended up being quite a journey.

The topics of this dissertation were in many ways embodied in the process itself and gained continuous experiential ground. The increasingly common fixed timelines and contracts, changing teams and collaborating organizations, and the general uncertainty of current working life was constantly present in the process. Perhaps it has always been relatively common in the academic context. Like most doctoral researchers, I have worked on several research projects, in many different team configurations, and have constantly applied for continued funding, either for a project or in the form of a personal grant. Just like any field, the academic world is not free from challenging working life phenomena either. During the doctoral journey I also worked in diverse locations and physical environments, many of them topical with regard to the phenomena of current working life and this

dissertation. I started in the somewhat legendary Room 314 at Siltavuorenpenger, sharing the old classroom with 3–5 fellow doctoral researchers and research assistants. We then moved to a new EWE multispace office in the Minerva building. I also worked quite a lot at the library or at home.

Towards the end of my dissertation process, I returned to the North of Thailand and Southeast Asia. This part of the process was not preplanned either, but it turned out to form the practical frame for the final phase of my PhD work. I worked on the dissertation from my living room, mostly in Chiang Mai, Thailand, but also in Bali, Hanoi and a couple of other places. Some of the context-specific challenges included issues resulting from diverse ergonomic aspects (e.g. tools, furniture, noise, cognitive burden), power cuts, breaking wifi connections, transient relationships and thin sense of community, having to migrate to another country because of toxic air pollution, then dealing with new unexpected environments, dealing with the stressors related to living as an expat in a foreign country, and of course, high demands for self-regulation and self-leadership. Despite all of these aspects, it was highly engaging and inspiring and made absolute sense.

Communication with supervisors and coworkers took place via digital media. Of course, my supervisors were often on the move too: I remember one time when I was in Chiang Mai, Kirsti was in Taipei, Katariina in California, and Kaisu in Brazil. Relying on long distance communication was not typical or always easy, and I knew of no-one else finishing a PhD in this way, but there also was no reason not to. This was a good example of the opportunities that current working life offers, and the novel potential created by digitalization.

With most work being carried out on a computer and with communication technology having greatly evolved, working life has already moved beyond the phenomena of remote work and multilocational work. This new wave has brought about a growing number of digital nomads, of whom I have also been one. It is no longer about occasionally working in different places, but possibly letting go of the idea of a permanent address altogether and your entire life being on the move; moving your home and laptop freely from one place to another and working wherever you are at a given moment. Currently, Chiang Mai is globally one of the major hubs for digital nomads. Being a part of this movement has been very inspiring. This is also a highly interesting, novel topic for future research.

With regard to the content of my dissertation, it strangely makes sense that it is being published in the surprising conditions resulting from the coronavirus pandemic. The doctoral defense will be mostly carried out remotely and via digital media. This has not normally been an option, but now we have had to adopt new practices in an instant. The topic of remote, multilocational work and related meaningful practices are more topical than ever.

The entire world has been forced to adapt to new remote work practices more quickly than we would ever have imagined. Families and even

schoolchildren are working from home, having conference calls in their living rooms and learning to use novel communication technologies around their kitchen tables. Rather surprisingly, in most cases, this actually works. People are immensely resilient and able to adapt and learn new ways in order to overcome challenges; even turn them into assets. Perhaps this time of crisis will yield meaningful practices and lower the barrier to utilizing these options even after this exceptional time. However, it is clear that all this is not without its problems. Support is needed for learning new practices: each individual must be ready to respond to these new demands, as an imbalance between demands and resources can turn into a stressor. Face-to-face encounters are still required and the need for physical human connections cannot be neglected.

In many ways, my doctoral journey indeed ended up being quite a trip. It lasted approximately seven years, blending with a couple of other projects along the way. Those years included some stable everyday life, but also some major life changes. Overall, they definitely included some of the absolute happiest and absolute hardest times of my life. There are many people whom I wish to thank for all the support I received and also just for the joy of sharing life together. You made this process possible.

First, my supervisors, Kirsti Lonka, Katariina Salmela-Aro and Kaisu Mälkki, and the community of home university - I have learned so much from your world-class expertise. Over these years, I have grown professionally a lot and my expertise has broadened and become more diverse, and your role in it has been significant. Kirsti, you played a big part in me embarking on this journey to begin with, and in the phenomena that I ended up researching. The areas that you work on are cutting edge, and I probably would not have discovered them otherwise. You also gave me many valuable pieces of advice that ended up playing a substantial part in my work, such as referring to self-determination theory as one possible theoretical framework, or to minor studies of Leadership and Knowledge Management at Aalto University. I have learned a lot from you about the importance of community: you emphasize this a lot and truly have a skill in bringing people together. I also highly appreciate your approach to academic work in that it should also be fun! The research group has certainly been a living example of that. You have also always been very generous with sharing your professional network; I too have had the opportunity to connect with a number of great people, some of which have yielded further collaboration, and I wish to sincerely thank you for that. Katariina, you are an outstanding leading professional in your field and I am delighted that we got to collaborate in this process. Even though our collaboration was not as broad as with the other two supervisors, every time we met, I received valuable and accurate comments, reflections and advice from you. I also highly appreciate your kind and empathic presence in the supervising process. Kaisu, with you this path has covered many different areas and roles, in all of which you proved to be an irreplaceable companion and support. Thank you for your invaluable, always spot on and precise

comments and reflections. You are a rock solid, insightful, reliable professional that truly has the skill of mentoring others to reach their own best potential. In addition, you are great company and a dear friend.

I have also learned a lot from all of my supervisors about how the academic world works. One such practical example has been really skilled guidance in applying for funding, which plays a substantial part in enabling the work in the first place and will likely be a very useful skill in future as well. Finally, I also wish to thank all my supervisors for bearing with me and being flexible with the challenges of concluding the last phases remotely and in an unconventional way.

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I have had the opportunity to learn a variety of new skills and deepen my professional expertise, and I have had the honor of meeting many nationally and internationally leading experts, especially in the field of motivation. My memorable experiences include many amazing, inspiring and fruitful conference trips: the Transformative Learning Conference in NYC with my supervisor, coworker and friend Kaisu Mälkki; the SELF conference on positive psychology and well-being with Kaisu Mälkki in Kiel; the EARLI conference with the coworkers from the research group of educational psychology in Cyprus; the self-determination theory conferences in Rochester and Amsterdam, the latter in the company of our wonderful Finnish SDT crew; and the EAWOP conference in Dublin with a great Finnish work and organizational psychology context crew, which included our world class researchers and lovely colleagues Matti Vartiainen, Jari Hakanen and Virpi Ruohomäki.

One special experience and exquisite opportunity was also my time in Rochester: I visited the Human Motivation Research Group at the University of Rochester on a short researcher exchange and had the opportunity to personally meet and learn from professor Edward Deci. In the context of self-determination theory, I have had the fortune and joy to meet both founding professors, Edward Deci and Richard Ryan and attend their lectures, teaching and workshops several times. Each time has been insightful and inspiring and offered important reminders of why I am doing what I am doing. They have

always been authentic, warm encounters and embodied the essential features of the theory itself. Perhaps needless to say, all of these openings and influences have offered a multitude of opportunities to delve into and gain more understanding of the profound questions that I had prior to starting work on my dissertation. Overall, I am quite amazed by and extremely grateful for having been so lucky to have all these amazing opportunities.

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It has become increasingly clear to me how privileged I am; indeed, we are. Circumstances play a great part in the process of developing one's skills. A child having even one warm adult figure in their life who is interested in them and believes in them, is key. I have been blessed. I also happened to be born in Finland, which in conversations with people from elsewhere nearly always comes up as having an excellent education system and equality. My

circumstances have been favorable to say the least, and have enabled this process. As much as I appreciate and love international opportunities and connection and collaboration beyond borders, I highly value my home country and the immense work of previous generations in building it and ensuring the opportunities that we have today.

I am now in what feels like the safe pocket of my most recent temporary home in Taka-Töölö, Helsinki, hearing the seagulls scream and seeing the sprouts and buds emerging in the bright daylight as we approach May in this strange and memorable spring. As I write this section, the world is on its knees in the face of the COVID-19 pandemic, estimated to be the greatest global crisis since World War II. Profound questions concerning basic human needs, life and death abide. It almost seems trivial to be focusing on finishing a PhD; there are other things so much more important than this. But at the same time, it is never insignificant to offer what you can and contribute to the world in some meaningful way, however big or small. I hope that this dissertation will serve in having a positive impact on working life and on the lives of individual people, families and communities.

Kirsi Sjöblom
Helsinki, 29.4.2020

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LIST OF ORIGINAL PUBLICATIONS

The dissertation is based on the following original publications:

- I Sjöblom, K., Mälkki, K., Sandström, N., & Lonka, K. (2016) Does physical environment contribute to basic psychological needs? A self-determination theory perspective on learning in the chemistry laboratory. *Frontline Learning Research*, 4(1), 17–39. doi: <https://doi.org/10.14786/flr.v4i1.217>

- II Sjöblom, K., Lammassaari, H., Hietajärvi, L., Mälkki, K. & Lonka, K. (2019) Training in 21st century working life skills: How to support productivity and well-being in multi-locational knowledge work. *Creative Education*, 10, 2283–2309. doi: <https://doi.org/10.4236/ce.2019.1010164>

- III Sjöblom, K., Hietajärvi, L. & Salmela-Aro, K. (in press) Measuring broad self-regulatory skills in multi-locational knowledge work. *InPractice - The EAWOP Practitioners E-journal*.

The publications are referred to in the text by their roman numerals (Studies I-III) or in plural by substudies. Study II included Study 1 and Study 2. They are referred to in the text by Part-study 1 and Part-study 2. The dissertation as a whole is referred to in the text by dissertation study.

1 INTRODUCTION

This doctoral dissertation addresses the topical opportunities and challenges created by digitally mediated knowledge work. It focuses in particular on the role of modern knowledge work environments in the users' productivity and well-being and aims to produce new knowledge on how these environments and tools can best be utilized to support this. If the human perspective and the prerequisites for healthy and effective human functioning are not understood, unintentional practices related to modern environments and digital tools may pose a threat to both productivity and sustainability. This dissertation approaches these questions from the viewpoint of motivational psychology, educational psychology, work and organizational psychology, and occupational health research.

The rapid development of digital technology, along with increasingly stimulating and abstract surroundings poses challenges to both accustomed work practices and the well-being and productivity of employees (e.g. Bosch-Sijtsema, Ruohomäki & Vartiainen, 2009, Landy & Conte, 2016; Sparks, Faragher & Cooper, 2001). An increasing proportion of work is knowledge intensive and multi-locational, and at the same time less clearly defined and more autonomous than before (Brinkley, 2006; Ojala & Pyöriä, 2018; Rüdiger & McVerry, 2007). Work is decreasingly defined by time and place, and increasingly diverse in terms of both (e.g. Vartiainen & Hyrkkänen, 2010). It takes place in complex embedded physical, digital and social surroundings (e.g. Nenonen et al., 2009; Vartiainen & Hyrkkänen, 2010). While these changes in the particular surroundings and circumstances of present-day knowledge work open up unforeseen possibilities and may potentially support both productivity and well-being, without deliberate, well-functioning practices they also entail many potential stress factors (Bosch-Sijtsema, Ruohomäki & Vartiainen, 2010; Vartiainen & Hyrkkänen, 2010; Zijlstra & Sonnentag, 2006).

In order for knowledge work to be productive and sustainable, it is crucial to manage available psychological resources efficiently. Both individuals and organizations firstly need more knowledge on what supports productivity and well-being in this kind of work, and second learn to apply strategies that are based on this knowledge. For example, the characteristics of modern knowledge-intensive work require new kinds of leadership practices in organizations (De Paoli, 2015; Lonka, Ketonen, Marttinen & Talvio, 2019), and new kinds of individual skills, such as self-regulatory skills, to manage work and the psychological resources available for it (Ananiadou & Claro, 2009; Lonka et al., 2015). The more complex and undefined the environment and the less it provides structure, the more individuals needs to regulate their own functioning.

The topical challenges related to modern environments and tools can be approached on the one hand from the perspective of modifying the environment and tools to better meet the needs of the users, such as accommodating for individual work and collaborative knowledge creation (Scardamalia & Bereiter, 2014), and on the other hand from the perspective of developing practices on the individual and group level to proactively manage one's circumstances, in particular in cases in which modifying the environment is not possible. Some examples of

related topics that have been studied in recent years are multi-locational work, multi-space offices and the effects of digital tools and applications; all of which have the potential to both support cognitive functioning or, respectively, substantially disperse and consume it (see e.g. Bosch-Sijtsema, Ruohomäki & Vartiainen, 2010; Boutellier, Ullman, Schreiber & Naef, 2008; Haapakangas, Hongisto, Varjo & Lahtinen, 2018; Moisala et al., 2016; Pashler, 1994). In present-day working life, many employees need support for learning skills such as cognitive load management and stress management (Sparks, Faragher & Cooper, 2001), and for using modern tools (Ananiadou & Claro, 2009).

In fact, finding ways to successfully cope with mental overload is a substantial challenge that goes beyond workplaces: mental overload and stress have become one of the most prevalent health risks worldwide, and developing sustainability strategies required by different life domains has become crucial (OECD/EU, 2018; WHO, 2013). According to Finnish health research, every fourth Finnish adult has experienced burnout (Koskinen, Lundqvist & Ristiluoma, 2012). While excess mental burden needs to be attended to, fostering the thriving of human resources is not a minor question either: in modern societies and organizations, human resources are one of the most valuable currencies (e.g. Guthridge, Komm & Lawson, 2008). Changes in society and working life are making simple tasks automatized, and the potential of individuals is mostly needed for solving complex problems (Kauhanen, 2014). Economies are becoming more knowledge based; economic success is increasingly based on the utilization of intangible assets such as knowledge, skills and innovative potential as the key resource for competitive advantage (Brinkley, 2006). In Finland, one of the nation's internationally most important assets remains its high standard of education, learning and top human know-how (Vapaavuori, Lindroos & Hjelt, 2013).

In the context of education, the need to support a new set of skills and foster human potential has been recognized for some time: competencies required by current and future working life, also called 21st century skills (Ananiadou & Claro, 2009; Lonka, 2018), are being included in the curricula of comprehensive schools worldwide. Some examples of these competencies are self-regulation, cognitive load management, the ability to collaborate in networked systems and to use digital tools. In working life, however, the need to develop these skills is not always acknowledged or supported, despite the fact that current working life requires autonomy, self-regulation and psychological resource management of employees in ways that were unheard of a few decades ago. The fact that the majority of employees are high-functioning experts may falsely lead one to assume that they inherently possess specific abilities to self-regulate and manage their mental resources. However, these skills are distinct from the specific professional abilities of each employee.

This dissertation aims to respond to the aforementioned challenges in the following way. The general research question of the dissertation is: How can learning, productivity and well-being be supported in modern work and study environments? In the substudies, I examine more closely the ways in which the physical environment and tools can support or hinder the learning process, the role of these with regard to motivation, interventions that can be developed in order to enhance their use in ways that support productivity and well-being, the skills that individuals need in order to utilize them as part of their work, and ways in which to assess these skills. The dissertation responds to the topical need to support employees'

productivity, well-being and sustainable work. It offers both further theoretical understanding and practical tools for individuals and organizations to identify opportunities and challenges and to utilize digital technology and multi-locational spaces in ways that support productive, sustainable knowledge work. Although many societal factors also play a significant role in the current challenges of working life (e.g. Dufva, Halonen, Kari, Koivisto, Koivisto & Myllyoja, 2017), the scope of this dissertation is to approach these topics from the perspective of the psychological functioning of individuals and groups and the proactive options that are available to individuals and organizations.

In the following I describe in more detail the theoretical background from which this dissertation approaches the research questions.

2 THEORETICAL FRAMEWORK

To reach a sufficient depth in understanding the question of how to support knowledge workers' productivity and well-being in modern environments, this dissertation studies the research questions combining the research traditions of motivational psychology, educational psychology, work and organizational psychology and occupational health research. The specific combination of these research traditions was chosen on the basis of each of them being able to explain certain central aspects of the phenomena but being limited with regard to some other phenomena focal to the research questions under study.

More specifically, educational psychology has brought a great deal of valuable insight into the novel competencies required by today's society, also called 21st century skills, but has mainly focused on these in the context of education rather than working life. The emphasis has been on what children need to be taught in order for them to adjust well to future working life, rather than on looking into the developmental needs of those already working within this rapidly changing context. Educational psychology has also long acknowledged that human cognition is distributed between the individual and their social and physical surroundings. Thus, as a research tradition, it recognizes and explains the importance of the physical environment and tools in intellectual functioning but fails to provide detailed knowledge on the relations between modern environments and tools, productivity and well-being. Therefore, the current knowledge offered by occupational health research is essential for understanding these issues as contributing to the phenomena under study. Organizational psychology, on the other hand, describes and explains some of the focal elements of current working life, such as the nature, possibilities and challenges of knowledge work and multi-locational work. Finally, self-determination theory is one of the leading theories for understanding motivation, development and healthy human functioning. It explains human behavior, including the positive driving forces and resources of individuals and the role of the environment in supporting or hindering their actualization. Self-determination theory is established and applied in the contexts of all of these aforementioned broader research traditions, and the included mini theory of basic psychological needs offers a theoretical tool for approaching the phenomena under study. However, self-determination theory, for its part, has lacked emphasis on the role of the physical environment and tools in human functioning. For these reasons self-determination theory was chosen as the background theory for the study, combined with the essential completing knowledge offered by the research traditions described above.

The following subchapters of the theoretical framework explain the focal aspects that each of these approaches currently brings to understanding how learning, productivity and well-being can be supported in modern work and study environments. The substudies of this dissertation then actively elaborate on the combination of these approaches and empirical methods in order to gain further understanding of the phenomena under study.

2.1 DEFINING THE CORE CONCEPTS: KNOWLEDGE WORK, MULTI-LOCATIONAL WORK, PRODUCTIVITY AND WELL-BEING

Along with digitalization and the automatization of work, a growing number of individuals are working within the field of knowledge work in some way (Brinkley, 2006; Rüdiger & McVerry, 2007). Knowledge work refers to work that involves the (a) creation, distribution or application of knowledge as task contents, (b) by highly skilled and/or trained workers who have autonomy in their work, (c) who use tools (e.g. information and communications technology) and theoretical concepts, (d) in order to produce complex, intangible and tangible results (e) to provide a competitive advantage or some other benefit contributing towards the goals of the organization (Bosch-Sijtsema, Ruohomäki & Vartiainen, 2009; Bosch-Sijtsema, Ruohomäki & Vartiainen, 2010). Knowledge work is also increasingly becoming learning work and knowledge-intensive organizations are becoming learning organizations: the knowledge or skills an employee comes with is not as important as their ability to constantly learn more and the organizations being able to support and enable this (Chinowsky & Carrillo, 2007; Morgan, 2016; Tynjälä, 2008).

Typically, knowledge work is to a large extent digitally mediated (Harrison, Wheeler and Whitehead, 2004). In addition, with the advances in digital technology, it is no longer tied to a specific time or place in the same way more traditional forms of work have been. Indeed, it is increasingly common for work to be multi-locational by nature (Ojala & Pyöriä, 2018). Multi-locational work refers to work that is carried out in many different locations: offices, homes, public spaces such as cafes or airports, and mobile locations such as cars or trains (Hislop and Axtell, 2009). From the employees' perspective, such work can be liberating and inspiring but also stressful and draining (Koroma, Hyrkkänen & Vartiainen, 2014).

Overall, knowledge work is demanding both cognitively and socially, and includes a high level of mental regulation (Vartiainen, 2014). In addition, operating in mobile locations, as well as work being digitally mediated, bring about certain challenges for productivity and well-being (Bosch-Sijtsema, Ruohomäki & Vartiainen, 2010; Moisala et al., 2016; Vartiainen & Hyrkkänen, 2010). The overall relationship between information and communication technologies (ICT), location and physical mobility is a highly complex one (Gareis, Lilischikis & Mentrup, 2006). In order to arrange this kind of work in purposeful and functional ways, the mental workload factors related to mobile multi-locational work must be identified and managed (Vartiainen & Hyrkkänen, 2010).

The topics of productivity and well-being in knowledge work both cover a wide array of constructs and measures. Productivity in knowledge work is a complex construct, and measuring productivity in knowledge work is challenging (Bosch-Sijtsema, Ruohomäki & Vartiainen, 2009; Ramírez & Nembhard, 2004). The nature of knowledge work is complex and not easy to observe, making it also difficult to evaluate. The methods for measuring productivity in knowledge work are based on a number of productivity dimensions (e.g. quality, outcome and cost) (Ramírez & Nembhard, 2004). There is no unambiguous consensus on how to define productivity in knowledge work. It is also important to point out that in addition to more direct measures of productivity in one's own work, indirect factors, such as knowledge sharing

between coworkers in organizations, also play an increasingly important part (see e.g. Stenius, 2016).

As regards well-being, research in this area has evolved from minimizing harmful environmental effects and individual ill-being to fostering the thriving of human potential, and studying phenomena such as motivation, engagement, personal growth and happiness (Donaldson & Ko, 2010; Gable & Haidt, 2005, Hakanen, 2004; Hakanen, 2018). Despite this general shift in emphasis, both minimizing excess burden and supporting human functioning beyond the neutral remain essential. Recently, this kind of integration of positive and negative phenomena is expanding towards a new paradigm within the context of the psychology of well-being (see e.g. Bakker, Albrecht & Leiter, 2011a; Bakker, Albrecht & Leiter, 2011b; Salmela-Aro, 2017; Salmela-Aro & Read, 2017).

This dissertation approaches well-being from the perspective of both occupational health and stress (Maslach, Schaufeli & Leiter, 2001), as well as positive phenomena such as motivation (Ryan & Deci, 2017), work engagement (Hakanen, 2004; Hakanen, 2018; Schaufeli & Bakker, 2010) and self-regulation (Boekaerts, Zeidner & Pintrich, 2000). Productivity, on the other hand, is examined from the perspective of learning in higher education and productivity at work as described by the participants themselves, as well as by measuring specific work-related phenomena and practices that have shown to be related to productivity, such as basic psychological needs (Ryan & Deci, 2017), work engagement (Hakanen, 2004; Hakanen, 2018; Schaufeli & Bakker, 2010; Schaufeli, Bakker & Salanova, 2006) and proactive self-regulatory micro-practices such as taking sufficient breaks or limiting distractions (explicated in more detail in Section 2.4). The specific constructs and measures of well-being and productivity used in this dissertation are described in more detail in the Methods section.

2.2 MODERN KNOWLEDGE WORK ENVIRONMENTS AND MOTIVATION – SELF-DETERMINATION THEORY AS THE BACKGROUND THEORY OF THE DISSERTATION

This dissertation approaches the topic of how to support knowledge workers' productivity and well-being in modern environments from the perspective of motivational psychology, educational psychology, work and organizational psychology, and occupational health research. Self-determination theory is one of the leading theories on human motivation, development and well-being (Deci & Ryan, 1985; Deci & Ryan, 2000; Ryan & Deci, 2000; Ryan & Deci, 2017) and has been applied in all the aforementioned contexts for decades. This dissertation utilized it as a theoretical framework for approaching the phenomena under study.

Self-determination theory consists of six mini theories. This dissertation focuses on the mini theory of basic psychological needs, which sees the basic needs of autonomy, competence and relatedness as essential nutrients for healthy and effective human functioning. Autonomy refers to a sense of willingness, endorsement or volition, competence refers to a sense of confidence and effectiveness, and relatedness refers to a sense of belonging, inclusion and feeling connected to others (Ryan & Deci, 2002; Ryan & Deci, 2017; Ryan, 2019). Contrary to common misunderstandings related to the theory, autonomy does not mean independence; it means that

the individual's actions are in concordance with their values and interests (see e.g. Chirkov, Ryan, Kim & Kaplan, 2003). Thus, a person can be autonomously dependent on another person, recognizing the value of this and autonomously choosing it. Autonomy is not in conflict with relatedness. Nor does autonomy mean freedom or lack of restraints; rather, the individual can understand the legitimacy of these aspects and autonomously endorse them. (e.g. Ryan, 2019).

According to self-determination theory and the theory of basic psychological needs, individuals are self-determined, active and curious by nature, and this healthy behavior is either enabled or hindered by the environments in which they function. This is also the underlying basic assumption of this dissertation – individuals have the potential to be proactive, self-determined and engaged, but the environment in which they function must sufficiently support this (e.g. Ryan & Deci, 2000). According to extensive research, environments that support the satisfaction of basic psychological needs also support motivation and well-being (Deci & Ryan, 2000; Deci & Ryan, 2014; Ryan & Deci, 2000; Ryan & Deci, 2002).

More specifically, self-determination theory essentially differentiates between autonomous and controlled motivation, the former being related to sustained motivation, higher well-being and higher-quality performance, and the latter to shorter term effects and lower well-being. Autonomous forms of motivation can be reinforced by supporting the fulfillment of basic psychological needs. As a practical example of the effects of an autonomy-supportive or controlling environment in working life, a large number of scientific studies have found that simply exerting external control, as opposed to listening to employees' perspectives and allowing and trusting them to choose the most effective ways to approach and carry out their work, severely impairs motivation, well-being and personal initiative for work (see e.g. Deci & Ryan, 2014). In a nutshell, control leads to compliance, whereas autonomy leads to motivation (Ryan, 2019).

Self-determination theory strongly emphasizes the role of both the social and cultural environment in supporting well-being and enabling motivation. However, although the theory has been applied extensively in many different contexts, including work and education, for the most part, physical environment and tools have not been emphasized as part of an environment that supports or hinders basic psychological needs and healthy human functioning. As the area of modern environments and digital tools is increasingly becoming a focal part of everyday living, the topic has very recently started to emerge in self-determination research. As a partly overlapping emphasis to that in this dissertation, a recent study by Peters, Calvo and Ryan (2018) elaborated on how technology designs may support or undermine basic psychological needs, at best increasing motivation and engagement and improving user well-being. The interrelations between the study and this dissertation are discussed in the Discussion section.

This dissertation aims to utilize self-determination theory as an applicable framework for understanding the phenomena under study, but also to broaden its perspective by studying the role of physical environment and tools in contributing to individuals' experience of autonomy, competence and relatedness. This is essential, as although previous research has recognized the role of the social and cultural environment as either supporting or hindering basic psychological needs, it has neglected the role of the physical environment. This topic is examined in Study I in particular, but Study II also explains the more concrete relations between the characteristics, environments and tools of modern knowledge work and basic psychological needs. Study I also

explains in more detail the self-determination theory, the theory of basic psychological needs, some of the criticism presented, and the related research.

2.3 THE ROLE OF PHYSICAL ENVIRONMENT AND DIGITAL TOOLS IN CONTEMPORARY KNOWLEDGE WORK, PRODUCTIVITY AND WELL-BEING

Human cognition is socially and physically distributed: the tools and social and cultural environments that are available affect the quality of intellectual and creative pursuits, potentially elevating or challenging human potential (Hakkarainen, Palonen, Paavola & Lehtinen, 2004; Hutchins, 2001; Norman, 1993; Scardamalia & Bereiter, 2014). Social interaction and environments scaffold individual abilities (Vygotsky, 1978), and physical environments entail the same potential, mobile spaces and digital tools being no exception. Each environment offers affordances (Gibson, 1977; Norman, 1993) that enable certain kinds of activities and nudge the user in a certain direction, such as a cell office towards quiet work and individual work orientation. In fact, physical environments and tools play a significant role in supporting or hindering productivity and well-being (e.g. Hakkarainen, Palonen, Paavola & Lehtinen, 2004; Korpela, Nummi, Lipiäinen, De Bloom, Sianoja, Pasanen & Kinnunen, 2017; Powell, Piccoli & Ives, 2004; Vartiainen & Hyrkkänen, 2010; Zijlstra & Sonnentag, 2006), and should therefore be utilized appropriately.

Contrary to more traditional or concrete forms of work, digitally-mediated knowledge work seldom requires a specific physical space in which to work, or one that is shared by the entire work community. What is characteristic of contemporary knowledge work is that it takes place in embedded physical, digital and social surroundings (Nenonen et al., 2009), digital environments partly replacing the shared physical space. While employees work in a given physical setting, they are often simultaneously present in numerous digital communities as well (e.g. Nenonen et al., 2009; Vartiainen & Hyrkkänen, 2010). With complex physical, digital and social work environments, one might claim that individuals are actually functioning in many different worlds at the same time, which is yet rather different to responding to stimuli and challenges posed by one immediate world.

Another trend in current working life, and in work environments in particular, is not only physically dispersed locations, but also new kinds of office environments. Many companies are shifting from traditional one-person offices to multi-space offices, in which employees typically have no designated desk but a number of shared spaces, designed to enable different kinds of tasks such as collaborative work or quiet individual work (e.g. Boutellier, Ullman, Schreiber & Naef, 2008). With an ever-growing proportion of work being automatized, the input needed from employees increasingly requires collaborative problem-solving in a team of experts (El-Farr, 2009; Lonka, 2018). Thus, the work environment needs to sufficiently accommodate collaborative knowledge creation (Scardamalia & Bereiter, 2014). In addition to the functionality of the spaces and the novel needs of working life, cost-efficiency is also a reason for arranging work environments in this way (Gareis, 2003): it is typical for office space to be empty for much of the time, and this is even more often the case in multi-locational work.

At best, these abovementioned changes in work environments accommodate the needs of individual employees better than before. Some of the potential assets include minimizing unnecessary transitions from one physical location to another, more options for scheduling work and personal time, generally more autonomy (Vartiainen & Hyrkkänen, 2010), and opportunities to collaborate with others irrespective of geographic location (Hakkarainen, Palonen, Paavola & Lehtinen, 2004).

At the most basic level, in order to support productivity and well-being, physical environment and tools need to sufficiently enable healthy human functioning, for instance, from the perspective of ergonomics, light and sound (e.g. Bechtel & Churchman, 2003; Parsons and Hartig, 2000). As noted earlier, environment and tools also contribute to physically and socially distributed cognition, at best taking the users' skills to the next level and enabling activities that would not be possible without these resources. On the other hand, if, for instance, the environment fails to provide a sufficient sense of safety for the users, the stress originating from this is likely to impair the capacity for higher cognitive functions such as learning (e.g. Dominique, Roozendaal, Nitsch, McGaugh, & Hock, 2000; McEwen & Sapolsky, 1995; Sandström, Sjöblom, Mälkki & Lonka, 2013). Another practical example of physically and socially distributed cognition is the effect that the surrounding space has on the success of completing tasks; for example, working on a collaborative task in an environment that does not allow conversation, or alternatively, working on a highly challenging and focused individual task in a noisy environment filled with concurrent interruptions.

Physical spaces also demonstrate the culture of the community using them, not only by how they are designed but also by the agreements under which they are used (e.g. Mälkki, Sjöblom & Lonka, 2014). Physical spaces convey assumptions of expected practices and roles and as such are likely to also affect users' behavior (Mälkki, Sjöblom & Lonka, 2014). A simple example of this is an auditorium space that first and foremost directs users towards the role of listeners and receivers, the main activity taking place at the stage, predominantly one-directionally.

Although contemporary knowledge environments entail considerable potential for supporting both productivity and well-being, their opposite effect is also being widely researched. For example, modern work environments and digitally-mediated work typically challenge employees in terms of information overflow: overall stimuli are abundant, and communication happens through numerous information channels and devices, often simultaneously (e.g. Koroma, Hyrkkänen & Vartiainen, 2014). Other challenges posed by modern environments and tools may include adverse effects of multitasking on productivity and well-being (Moisala et al., 2016), inadequate work environments or tools for different types of tasks (Haapakangas, Hongisto, Varjo & Lahtinen, 2018; Koroma, Hyrkkänen & Vartiainen, 2014), lack of support or connection with colleagues (Koroma, Hyrkkänen & Vartiainen, 2014), or ineffective boundaries between work and rest (Vartiainen & Hyrkkänen, 2010; Zijlstra & Sonnentag, 2006).

However, it is important to note that environments and tools alone do not determine the quality of activity; the social practices in how they are used play a crucial role (Hakkarainen, 2009). In a knowledge-intensive workplace and society, knowledge practices, more specifically, play an important role. Knowledge practices are social practices that are related to working with knowledge, for example, practices related to communicating through various digital devices

and applications (Hakkarainen, 2009; Lonka, 2018). They include practices on different levels: personal, collaborative and institutional, and they may be either concordant or not. Thus, it is crucial to deliberately develop practices that support productivity and well-being on individual, community and organizational levels, as I further explain in the following sections of the theoretical background.

It is also important to acknowledge that the potential benefits and challenges created by modern tools are likely to be relational to the specific content and needs of the work being conducted. For example, it has been noted that face-to-face interaction in a shared physical space or through media that is as rich as possible is likely to be particularly important in cases in which the relationship and understanding between the participants is thin, whereas communication from a distance and through more limited media may effectively serve those who already have more common understanding and a shared culture of collaboration (Olson & Olson, 2000; Powell, Piccoli & Ives, 2004). The underlined need for rich encounters is not uncommon, as employees increasingly often work in geographically dispersed, virtually networked teams consisting of transient multicultural team members. Although this kind of specific knowledge regarding modern tools and related deliberate strategies is likely to be significant for the productivity and well-being of employees, established scientific knowledge on these topics remains limited and its application in everyday working life varies. This dissertation study aims to enhance the understanding of how modern environments and tools can best be utilized to support productivity and well-being, as well as of how to develop the practical tools and practices for doing so.

2.4 21ST CENTURY WORK – THE NEED FOR NEW COMPETENCIES AND PRACTICES FOR BOTH INDIVIDUALS AND COMMUNITIES

In terms of digitalization in particular, the characteristics and the environments of both society in general, as well as working life more specifically, have changed dramatically (Dufva, Halonen, Kari, Koivisto, Koivisto & Myllyoja, 2017; Kauhanen, 2014; Morgan, 2016; Ojala & Pyöriä, 2018; Rüdiger & McVerry, 2007; Vapaavuori, Lindroos & Hjelt, 2013). In order to utilize modern environments and tools as a supportive part of human functioning, new competencies and practices are needed (see e.g. Vartiainen & Hyrkkänen, 2010). On a global scale, a new set of skills, broadly called 21st century skills, are being included in comprehensive school curriculums. Some of these skills, which are regarded as necessary for current and future working life, are self-regulation, cognitive load management, novel thinking, creative problem-solving, the ability to collaborate in networked systems and use digital tools, and interaction beyond cultural borders. (Ananiadou & Claro, 2009; Lonka, 2018). However, the fact that adults do not have these new competencies as built-in qualities either has received much less attention in current research and applied work. Just like school children, employees also have varying abilities in terms of the required 21st century skills, and many employees need to consciously practice and learn these skills in order to acquire them.

A prominent trend in current working life and knowledge work in particular is the increasing autonomy and responsibility of employees, and respectively, the increasing need for leadership

to facilitate, support and enable this work (Bosch-Sijtsema, Fruchter, Vartiainen & Ruohomäki, 2011; De Paoli, 2015; Verburg, Bosch-Sijtsema & Vartiainen, 2013). Thus, current and future working life challenges the traditional roles and practices of both employees and leaders. Not only do autonomy-supportive work environments support both productivity and well-being (Deci & Ryan, 2000; Deci & Ryan, 2014), it is also virtually impossible to monitor or control knowledge workers' input in the same way as previously in more traditional or concrete work. For instance, an employee might get their most significant insight of the day while taking a shower at home in the morning, and very little progress may then happen during the actual working day due to a poor level of cognitive resources being available for one reason or another, such as simply being sleep deprived, or having experienced a recent stressful life event (Killgore, 2010; Kirschbaum, Wolf, May, Wippich & Hellhammer, 1996; LeBlanc, 2009; McEwen & Sapolsky, 1995).

The radical changes in the nature of the work tasks and in the environments in which individuals function may include aspects that profoundly challenge the sustainability of human resources (Bosch-Sijtsema, Ruohomäki & Vartiainen, 2010; Vartiainen & Hyrkkänen, 2010; Zijlstra & Sonnentag, 2006). The main tool needed for a large proportion of tasks in modern society is people's minds, and without thought-out strategies there is a tendency for them to be working non-stop, which poses a challenge to both productivity and well-being (e.g. El-Farr, 2009; Helliwell, Layard & Sachs, 2019). As mentioned earlier, successfully coping with mental overload and stress is a global challenge: the World Health Organization considers mental health and stress-related issues one of the most prevalent health risks worldwide and emphasizes the importance of developing sustainability strategies in different life domains (WHO, 2013).

It appears clear that as an increasing number of individuals work in the field of knowledge work, and as the capital of this work is human cognition, it is crucial to first and foremost foster employees' psychological resources. In addition, the fact that the work is conducted in complex surroundings adds to the need for broad self-regulatory skills and the management of psychological resources. On the most basic level, this may mean sufficient sleep and nutrition (Gómez-Pinilla, 2008; Killgore, 2010; Scholey, Harper & Kennedy, 2001) or a sufficient level of ergonomics at the workplace (e.g. Bechtel & Churchman, 2003; Parsons & Hartig, 2000); on a more refined level it may mean scheduling work tasks according to one's typical flow of vigor and alertness during the day (Rae, Stephenson & Roen, 2015; Wood & Magnello, 1992) and carefully choosing required digital applications and strategies for using these (e.g. Moisala et al., 2016; Pashler, 1994); limiting external and internal interruptions and noise (e.g. Salo, Salmela, Salmi, Numminen & Alho, 2017; Smallwood, McSpadden & Schooler, 2008; Varao-Sousa, Smilek & Kingstone, 2018); job crafting (Wrzesniewski & Dutton, 2001), utilizing emotional intelligence, emotion regulation and the support of positive emotions (Donaldson-Feilder & Bond, 2004; Fredrickson, 2001; Newman, Joseph & MacCann, 2010); and regulating exercise, breaks and recovery (Berto, 2005; Hillman, Erickson & Kramer, 2008; Korpela, De Bloom, Sianoja, Pasanen & Kinnunen, 2017; Korpela, Nummi, Lipiäinen, De Bloom, Sianoja, Pasanen & Kinnunen, 2017; Williams, 2017; Zacher, Brailsford & Parker, 2014).

There are many practical ways in which to foster cognitive resources and support productivity and well-being, as opposed to over-burdening and disintegrating cognitive

capacity and compromising the ability to focus on the most essential tasks. Developing purposeful knowledge work practices, especially regarding the usage of digital tools and multi-locational spaces, is of focal importance for the productivity and well-being of knowledge workers (see e.g. Bosch-Sijtsema, Ruohomäki & Vartiainen, 2010; Vartiainen & Hyrkkänen, 2010), and it is crucial that this occurs on both the individual and organizational level. However, rather surprisingly, support programs, scales for measuring the required skills, and general discussion on these topics within the academic community have been limited. This dissertation aims to respond to the need for this by presenting a training program that supports 21st century skills in multi-locational knowledge work as well as a new questionnaire instrument for measuring broad self-regulation in multi-locational knowledge work.

3 CONTEXT OF STUDY – RESEARCH AND DEVELOPMENTAL PROJECTS: RYM INDOOR ENVIRONMENT AND 3SPACES – TOWARDS INSPIRING WORKPLACES

The substudies were carried out as part of two larger projects: Study I was part of a research project called “RYM Indoor Environment” and Studies II and III were part of a developmental project called “3SPACES – Towards Inspiring Workplaces”. Both projects were carried out in collaboration with other executing organizations: RYM Indoor Environment had numerous participating organizations and 3SPACES – Towards Inspiring Workplaces was conducted in collaboration with the Haaga-Helia University of Applied Sciences. On behalf of the University of Helsinki, professor Kirsti Lonka was the Principal Investigator in both projects.

RYM Indoor Environment (2011–2015) (www.rym.fi) was funded by The Finnish Funding Agency for Technology and Innovation. The general vision of the program was to promote the productivity, satisfaction and health of indoor space users in an ecologically sustainable manner (Nenonen et al., 2015). The program had several multi-disciplinary work packages, with numerous participating research institutions, organizations and private sector actors.

Study I was part of the Future Learning Environments work package, which focused on creating new solutions for designing schools and universities in Finland. More specifically, Study I was part of research on university chemistry learning environments that were about to undergo renovations. The Future Learning Environments work package as a whole covered diverse research on physical environments and motivation, learning and well-being, and included demonstration projects in which new solutions for learning environments were jointly developed with users and designers; for example, Minerva Plaza engaging learning environment was designed at the faculty of Behavioural Sciences at the University of Helsinki in 2012. The idea was to redesign physical and virtual learning spaces by relying on a combination of innovative pedagogical methods, novel forms of socio-digital participation, and interior design (Lonka, 2018). The aim was to create dynamic spaces that could be adapted according to the goals of each given activity.

3SPACES – Towards Inspiring Workplaces (2015–2017) was funded by the European Social Fund. The project was a part of a larger program focusing on sustainable growth and work (<https://www.rakennerahastot.fi/kestavaa-kasvua-ja-tyota-2014-2020-ohjelma>). Its main goal was to enhance productivity and well-being at workplaces, taking into account the needs of different aged employees and aiming to develop sustainable work practices and extend careers. Based on the topical challenges of multi-locational knowledge work, the focus of the project was not only on traditional occupational psychology perspectives on well-being (mental space), but also on developing purposeful work practices related to physical premises (physical space) and digital tools (digital space), also taking into account the underlying social dimension (social space) (Sjöblom, Lammassaari, Huovinen & Lonka, 2016). Change management for this process was another focal topic of the project.

Developmental procedures were carried out on both the organizational and individual level, aiming to develop physical spaces and digital tools and the shared practices related to these, as well as individual proactive abilities to respond to the challenges created by today's multi-locational knowledge work, modern environments and tools. As a central procedure, a new training program was developed and carried out twice. Fifteen organizations participated in the training program, 1–6 employees from each one, resulting in a total of 36 trainees.

In addition to the training program and the development model of physical, digital and mental space (organizational and individual level), the results of the project yielded 10 developmental plans designed by the trainees focusing on their organization's focal developmental needs (organizational level), 36 storybooks on the trainees' own developmental process (individual level), as well as an openly available electronic publication (Sipilä, Starck & Wegmuller, 2017) and a video training program (Starck, Sjöblom, Sipilä, Lammasaari, Åberg & Lehtinen-Toivola, 2017). A more detailed description of the training program can be found in the original article of Study II.

4 AIMS

The general research question of the dissertation was: How can learning, productivity and well-being be supported in modern work and study environments? The specific research questions of each of the substudies were as follows:

1. What is the role of the physical environment in the experience of basic psychological needs? What is the role of the physical environment in the learning process from the perspective of basic psychological needs?
2. What kind of support do organizations and individuals need to be able to use multi-locational spaces and digital tools in ways that support productivity and well-being? Can individuals and organizations benefit from training in how to use multi-locational spaces and digital tools in ways that support productivity and well-being; and if so, how?
3. Can knowledge workers' self-regulatory skills related to productivity and well-being be measured by the scale presented in the study? Does the measurement model presented in the study show a good fit? How is the model related to established well-being at work scales?

This dissertation aimed to gain a deeper understanding of the relations between complex knowledge work environments and users' productivity and well-being, as well as of how these environments can best be utilized to support these. In terms of both research and applied work, the topic is still relatively new, and training programs that address the particular challenges of current knowledge work environments and tools in the light of current multidisciplinary knowledge, for example, are sparse. The general aim of the dissertation was to produce new knowledge and practical tools that contribute positively to productivity, well-being and sustainable work.

The substudies more closely examined the role of physical environment and modern tools with regard to motivation (I), interventions that can be developed in order to purposefully utilize modern spaces and tools as part of human performance (II), and specific skills that individuals need in order to make use of complex environments and tools as part of multi-locational knowledge work, as well as the assessment of these skills (III). Thus, the studies approached the topic from the perspective of theory, intervention and methodology. Figure 1 summarizes the core foci of the substudies, and how they built on each other.

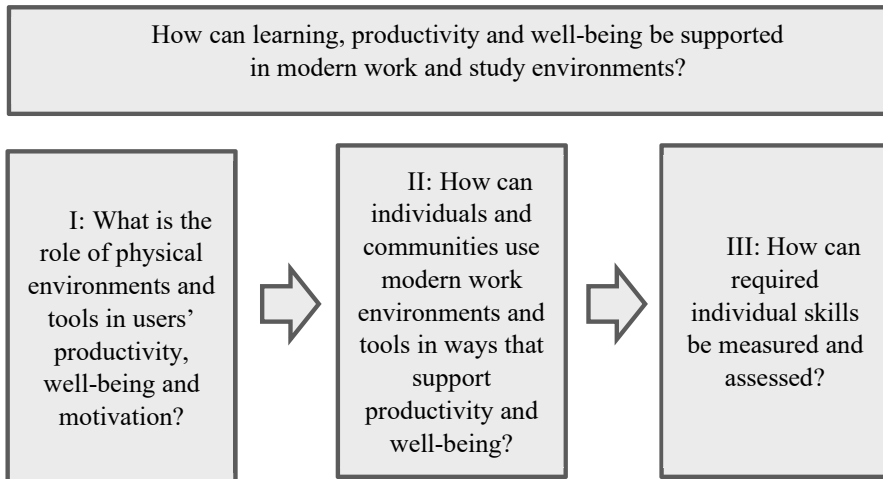


Figure 1 Progressive foci of substudies.

The specific aims of the studies were as follows: Study I aimed to explore the role of the physical environment with regard to learning from the perspective of basic psychological needs. It also aimed to expand the interactional perspective of the theory of basic psychological needs by considering the role of the physical environment in facilitating or hindering the satisfaction of basic psychological needs. Study II aimed to expand understanding gained in Study I and to obtain more information on the physical, digital, social and psychological aspects of the knowledge intensive, multi-locational work environments and on their role in productivity and well-being. Second, it aimed to further develop a training program on the basis of the results of the analysis, and to utilize the knowledge gained in the development process to further understand the phenomena. Study III responded to a need recognized in Study II: it aimed to develop a means to assess knowledge workers' self-regulatory skills related to productivity and well-being in multi-locational knowledge work and to identify developmental needs regarding these skills.

5 METHODS

5.1 PARTICIPANTS AND DATA COLLECTION

The data was collected from Finnish early-stage university chemistry students (Study I) and from employees of public organizations, SMEs and start-up companies in the Finnish metropolitan area (Study II, III).

Study I's data collection took place in spring 2013 as part of a research project called "RYM Indoor Environment" (see Section 3 for a more detailed description). The participants (n=21) were selected on the basis of their willingness to participate as well as the appropriate timing of their current laboratory project: the data collection occurred during actual organic chemistry classes, and participation in the interview depended on whether they were able to leave their laboratory work for an hour to complete the interview.

Study II's data collection took place in the fall of 2015 as part of a developmental project called "3SPACES – Towards Inspiring Workplaces" (see Section 3 for a more detailed description). A total of 189 participants responded to a questionnaire conducted as an online survey. These were from the participating organizations (n=8, 1 municipal organization and 7 startup companies) and from organizations with no participants in the project (n=2, 1 university of applied sciences and 1 university) in order to ensure more diversity in the comparisons of the issues of interest (Part-study 1 of Study II). For Part-study 2 of Study II, 15 employees from the participating organizations responded to a questionnaire conducted as an online survey. These participants were trainees on a training program developed as part of the project.

Study III's data collection took place in the fall of 2016 as part of the same "3SPACES – Towards Inspiring Workplaces" developmental project. Two hundred two participants responded to a questionnaire. These respondents were from two large public organizations participating in the project and the second round of the training program. The data were collected via an online survey.

Over two years, employees from altogether 15 organizations participated in the "3SPACES – Towards Inspiring Workplaces" developmental project and in this dissertation study. All the organizations were from the Finnish metropolitan area.

A more detailed description of the participants of each data set is presented in each of the original articles.

5.2 INSTRUMENTS

In Study I, the questionnaire that served as an orientation to the interview was designed by the authors (Sjöblom, Mälkki, Sandström & Lonka, 2016) and included both open-ended and multiple-choice questions. The themes of the questionnaire focused on the *helpful and challenging aspects of the physical environment with regard to learning* as well as the *typical study-related use of physical spaces, equipment and technological devices*.

In Part-study 1 of Study II, *Basic psychological needs at the workplace* were assessed using the Basic Psychological Need Satisfaction at Work Scale (Deci, Ryan, Gagné, Leone, Usunov & Kornazheva, 2001; Ilardi, Leone, Kasser, & Ryan, 1993; Kasser, Davey & Ryan, 1992). This included 21 items measuring the three components of basic psychological needs; *autonomy*, *competence* and *relatedness*. The scale was translated into Finnish by the first author (Sjöblom, Lammasaari, Hietajärvi, Mälkki & Lonka, 2019).

In the same study, *Perceptions of the work environment* were assessed using a set of 12 items covering different aspects of the participants' *physical*, *digital* and *social* work environment, ranging from possibilities to engage in quiet work to supportive social climate at work (the origin of the items: see Study II references).

In Part-study 2 of Study II, the questionnaire on *possible changes resulting from training* included 16 questions on *possible changes to work practices, the use of digital devices and applications, the use of physical spaces, productivity, well-being, motivation, social aspects of work, experiences of change, experiences of the most focal benefits of the training, and suggestions for further improvement of the training*. The questions were designed by the first, second and fifth authors (Sjöblom, Lammasaari, Hietajärvi, Mälkki & Lonka, 2019). The questionnaire included both multiple-choice and open-ended questions. The participants were first asked, using multiple-choice questions, whether changes resulting from training had occurred, and then, using open-ended questions, about the specific possible changes. Because of the nature of the research question and the limited sample size, the analysis presented in Study II focused on the open-ended questions.

Study III assessed *broad self-regulatory skills in multi-locational knowledge work* on a scale that consisted of 17 items and measured three components: *behavioral self-regulation*, *cognitive-emotional self-regulation* and *self-regulation regarding recovery*. The items were designed by the first author (Sjöblom, Hietajärvi & Salmela-Aro, 2019) (Appendix 1).

The same study assessed *work engagement* using the Utrecht Engagement Scale with nine items (UWES-9; Schaufeli, Bakker, & Salanova, 2006; Seppälä et al., 2009). This scale measured three dimensions: *vigor*, *dedication* and *absorption*. For the purposes of the analyses, we used the total composite UWES score (Schaufeli & Bakker, 2010; Schaufeli, Bakker & Salanova, 2006).

The same study assessed *burnout* using the Bergen Burnout Indicator (BBI-9; Feldt et al., 2013; Salmela-Aro et al., 2011). This scale consisted of nine items measuring the three core dimensions of burnout: *exhaustion at work* (emotional component), *cynicism toward the meaning of work* (cognitive component) and *sense of inadequacy at work* (behavioral component). For the purposes of the analyses, the subscales of exhaustion, inadequacy and cynicism were used.

5.3 PROCEDURES

This dissertation utilized both qualitative (Study I) and quantitative (Study III), as well as mixed methods (Study II). In order to capture the diversity and depth of the participants' experiences of a fairly new research topic, Study I approached the relations between the physical

environment and basic psychological needs using qualitative methodology. Semi-structured focus group interviews were conducted following an interpretivist approach (Scott & Usher, 1999; Williams, 2000), aiming to make “sense of actor's actions and language within their 'natural' setting” (Williams, 2000). The method of the interview was thus designed to leave space for the participants to freely discuss themes that they experienced as important. The interviews were then transcribed verbatim, and these transcriptions were iteratively analyzed in a data-driven manner by the authors, with the help of the Atlas TI program. Repeated stages of individual and collaborative analysis were conducted to find central categories and patterns in the reported experiences.

Study II applied mixed methodology: ANOVAs (Part-study 1) and qualitative content analysis (Part-study 2) (Joffe & Yardley, 2004; Liamputtong & Serry, 2013; Schreier, 2012). In Part-study 1 of Study II, a set of univariate analyses of variance was conducted to compare the selected organizations in terms of the satisfaction of basic psychological needs at the workplace as well as perceptions of the physical, digital and social work environments. The analyses were conducted using the IBM Statistical Package for Social Sciences 25. In Part-study 2 of Study II the qualitative reports on the possible benefits of the training were content analyzed in a phenomenon-driven manner. The analysis refrained from making strong presumptions or specific hypotheses that would have limited it. Instead, it was data driven, aiming at a more general conceptual understanding through inductive reasoning (Graneheim, Lindgren & Lundman, 2017; Schreier, 2012). The study also aimed to further develop the training program on the basis of the results of the analysis (Part-study 2), and to utilize the knowledge gained in the development process to further understand the phenomena. Thus, the approach of the study was design research, the focus of which is both theoretical and pragmatic, and the process of which advances in an iterative manner (Edelson, 2002).

Study III applied quantitative methodology to examine a new measurement scale. It first used the confirmatory factor analysis approach (CFA) to test the measurement model specified according to the theoretical background. The differences between the subgroups were examined using the independent samples t-test and MANOVA. The analyses were conducted using R and RStudio (www.rstudio.com; R. Team, 2015; R. Team, 2018). Second, latent variable correlation analyses were conducted to examine the relations between broad self-regulation factors and established well-being at work scales (work engagement, burnout). These analyses were conducted using the R-package qgraph (Epskamp, Cramer, Waldorp, Schmittmann & Borsboom, 2012). More elaborate descriptions of this method as well as the methods of Study I and II are presented in detail in each of the original articles.

5.4 ETHICAL CONSIDERATIONS

All the substudies were carried out according to the ethical guidelines of the Finnish Advisory Board on Research Integrity (National Advisory Board on Research Ethics, 2009). In designing the questionnaires and interviews, careful consideration was given to what information is actually required of the participants. Participation in all the substudies was voluntary, and this was emphasized each time a questionnaire or interview was introduced. The participants were

informed of the purpose of the study and the process related to the storage of the data and analysis of the results; for instance, that fact that the access to the data was granted only to the researchers of each research project, and that the data were analyzed anonymously and on a group level so that no individual participants or answers could be identified. The participants were asked for their consent to participate in the study and in the event that this was not granted, they were excluded.

6 RESULTS

6.1 STUDY I: THE ROLE OF PHYSICAL ENVIRONMENTS AND TOOLS IN SUPPORTING BASIC PSYCHOLOGICAL NEEDS, LEARNING AND WELL-BEING

Study I was carried out in the study context of higher education in chemistry, and it examined the role of the physical environment in learning and well-being from the viewpoint of self-determination theory and basic psychological needs. Moreover, it also more broadly investigated the role of the physical environment in the experience of basic psychological needs.

The study found that like social and cultural environments, physical environments can also either support or hinder the fulfillment of basic psychological needs in various ways. Table 1 summarizes the results of Study I regarding the relations between physical environments and basic psychological needs; a more detailed description of the results can be found in the original article.

Conclusion	Examples from data	Practical implications
Physically-mediated guidance and the use of modern technological devices may support students' sense of autonomy and competence.	Students wished for clear, well-structured spaces, where basic-level information may be implemented in the space, or be acquired with the help of technological devices, in order to enable them to navigate and function in the space in a self-directed manner. Socially-mediated guidance was regarded as important for confirming one's assumptions, in a facilitating rather than instructing manner.	It is important to distinguish between physically- and socially-mediated guidance and their purposeful roles. Physically-mediated guidance should be more widely acknowledged and utilized in communicating information on a basic level, such as where to find required equipment or dispose of substances, whereas social guidance is needed in more complex cognitive processing.
The physical environment may complement the students' existing competence and offer procedural facilitation for their learning processes.	The chemistry laboratory as a new and complex working environment seemed to be highly challenging, if not intimidating for the students at first. However, if the students managed to successfully enter and master the equipment and the space, this offered them fruitful and highly engaging learning experiences.	Students should be provided with suitable spaces and tools as well as sufficient guidance in using them in order to ensure the scaffolding of the learning processes by both physical and social means. The more complex the activity and the environment, the more cognitive structuring is needed.
Being able to utilize diverse learning environments in a self-directed manner may support students' sense of autonomy in directing and regulating their own learning process.	The students associated certain study activities as well as a certain value, status and ownership to different learning environments. Formal learning environments, such as lecture halls, libraries and laboratories, as well as the formal and focused learning activities occurring in these, were often perceived as more "proper" than the informal and collaborative learning environments and activities, even though the latter were experienced as crucial for the learning process.	Flexible, diverse and freely accessible spaces should be available for students in order to accommodate the variety of study activities as well as support students' sense of autonomy and relatedness. Informal environments may promote more sense of belonging and ownership in novice students; the possibility to act in a professional work environment may bridge the gap between the novice and professional stages and also bring a sense of meaning and purpose to studies.
The functionality of the physical environment contributes to the cognitive processes of the users as well as to the related emotional experience of acting in the given environment. Consequently, the physical environment may be instrumental in the development of the students' sense of relatedness to the professional community.	For the students, the laboratory strongly represented their future work environment as chemists, and the experiences occurring in it were frequently projected to their future professional identity. The functionality of the physical environment and the fluency of the activity appeared to contribute to the students' sense of belonging to the professional context.	Special attention should be paid to the functionality of the physical environment as well as to the fluency of short periods of practical work, as the experience of a physical environment builds through the activity performed in the environment.

Table 1 Summary of results of Study I.

To explain the main results of the study, the usability and functionality of spaces and tools contributed to not only the fluency of the intellectual activity but also to the related emotional experience of acting in a particular environment. The physical environment was a source of procedural facilitation (Bereiter & Scardamalia, 1987): It offered physically-mediated guidance and cognitive structuring for the students' learning processes. It complemented and challenged the students' existing skills, and thus contributed to their experiences of autonomy and competence within the context of the chemistry laboratory. Autonomy was also supported by the flexibility of physical environments and the related social practices: for example, the students described that with diverse learning environments and tools they were able to actively choose the best suited location and environment for a given task. The physical environment appeared to also function as a gateway to the related community and practices: the everyday successes or struggles in the laboratory, in which the functionality of the environment played a substantial part, contributed to the students' developing professional identity as well as their sense of relatedness to the professional community.

Overall, the results of Study I demonstrated that the design and functionality of the physical environment plays a significant role in users' intellectual and emotional functioning, and that learning and well-being can be facilitated by developing physical environments that support basic psychological needs.

6.2 STUDY II: HOW TO SUPPORT PRODUCTIVITY AND WELL-BEING IN MULTI-LOCATIONAL KNOWLEDGE WORK – INTRODUCING A TRAINING PROGRAM FOCUSING ON 21ST CENTURY WORKING LIFE SKILLS

Study II investigated the physical, digital, social and psychological aspects of knowledge intensive, multi-locational work environments and their role in productivity and well-being (Part-studies 1 and 2). It studied the kind of support that organizations and individuals need to be able to use multi-locational spaces and digital tools in ways that support productivity and well-being (Part-study 1). It presented a training program that focused on supporting well-being and productivity at work by developing the participants' awareness skills and behavioral strategies related to knowledge work, digital tools and physical spaces, and studied the benefits of this training (Part-study 2).

The results of Part-study 1 showed that the participants from different organizations had very diverse experiences of how well the environment and tools supported their work, and consequently, diverse needs for using multi-locational spaces and digital tools in ways that support productivity and well-being. For some organizations, the need to develop physical spaces to better meet work requirements was focal, such as having proper spaces for quiet work and breaks. For others, the main developmental need was support of employee autonomy and relatedness, or more efficient usage of digital tools. Examples of this could be brushing up

required competences, finding better suited digital applications, or agreeing on more deliberate and thought-out shared practices related to these.

The culture of each organization was manifested in the way in which the physical spaces were designed and used, and consequently, the kind of support needs they had. The organizations that had a strong collaboration culture and strong employee experience of relatedness tended to have work environments that were perceived as supportive of collaborative work but not necessarily of quiet, focused individual work. The reverse was true of the organizations that represented a more traditional approach to knowledge-intensive expert work. Similarly, the organizations that were perceived as particularly supportive of employees' autonomy, namely the startup companies, were trying out new things and seemed to be ahead of the others with regard to their digital tool practices. Based on the participants' elaborations on the topics during the training process, it also appeared that a large part of the work and collaboration in startup companies took place in digital environments, and that this was likely to affect the variety of ways in which the digital tools were used – they needed to complement face-to-face interaction in more diverse ways.

Table 2 and Figure 1 describe the differences between the organizations in perceptions of the work environment and basic psychological needs satisfaction at the workplace in more detail.

Item	Group								F	df	p
	University of applied sciences n = 36		Municipal organization n = 85		Startup companies n = 34		University n = 34				
	M	SD	M	SD	M	SD	M	SD			
Physical											
1. The physical spaces at my workplace support collaboration.	3.40	1.17	2.20 _a	1.14	4.61	0.56	2.18 _a	1.00	50.69	3,184	.000
2. The physical spaces at my workplace help employees concentrate.	2.74 _a	1.07	3.58 _b	1.14	2.82 _a	1.21	3.03 _{ab}	1.34	6.15	3,184	.001
3. My workplace provides peaceful surroundings for work.	3.26 _{ab}	1.20	3.59 _a	1.07	2.94 _b	1.22	3.33 _{ab}	1.05	2.90	3,183	.036
4. My work environment is very important to me.	4.42 _a	0.65	4.34 _a	0.75	4.52 _a	0.67	4.12 _a	1.14	1.46	3,184	.228
Digital											
5. I find that the technology at my workplace helps me do my work.	3.91 _a	0.98	3.14 _b	1.21	4.06 _a	1.01	3.44 _{ab}	0.89	7.77	3,183	.000
6. I look online for ideas, instructions and materials for my work.	6.11 _{ab}	1.17	5.81 _a	1.11	6.58 _b	0.94	6.09 _{ab}	0.75	4.36	3,185	.005
7. I ask my colleagues for help in work-related matters online.	4.26 _a	1.96	4.28 _a	1.98	6.06	0.97	4.65 _a	1.70	8.62	3,184	.000
8. The employees of my workplace work in an online community (e.g. Facebook group, Google group).	4.59 _a	1.99	2.97 _b	2.03	6.53	1.37	3.82 _{ab}	2.17	27.08	3,182	.000
Social											
9. Employees play an active role at my workplace.	3.69 _a	1.13	3.14 _b	1.09	4.64	0.65	3.53 _{ab}	0.90	17.80	3,183	.000
10. My superior encourages employees to express their opinions at the workplace.	3.77 _a	1.14	3.13 _b	1.08	4.52	0.67	3.53 _{ab}	1.16	14.47	3,184	.000
11. My superior is interested in how employees are.	3.69 _a	1.17	3.04 _b	1.25	4.50	0.76	3.53 _{ab}	1.16	13.10	3,183	.000
12. I am happy at my workplace.	3.60 _a	0.98	3.27 _a	1.12	4.39	0.75	3.56 _a	0.86	10.24	3,184	.000

Note: Groups sharing the same subscript did not differ statistically significantly at $p < .05$ with Bonferroni correction.

Table 2 Differences between organizations in perceptions of the work environment.

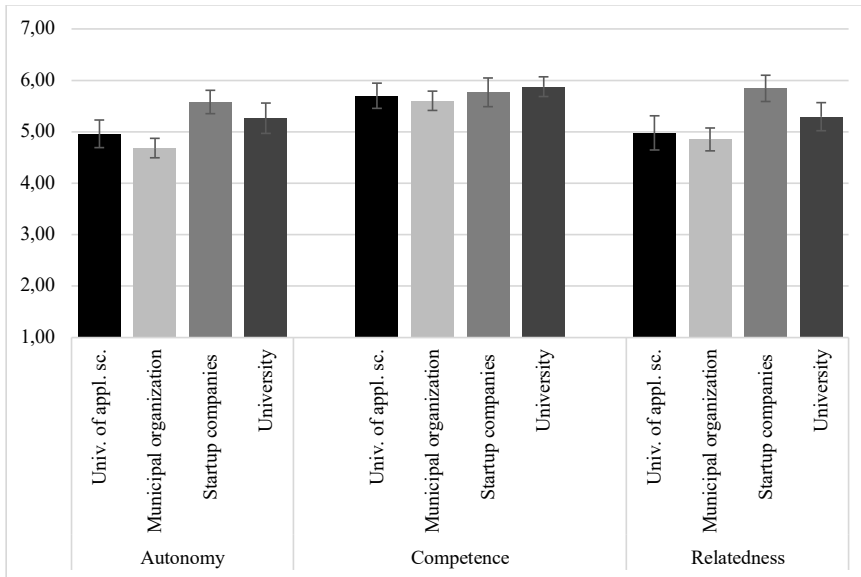


Figure 2 Differences between organizations in basic psychological needs satisfaction at the workplace.

In Part-study 2, the training program participants reported changes resulting from the training program on both individual and organizational levels. The core benefits pointed out by the participants were the development of awareness skills, such as becoming more aware of the accustomed practices and approaches to work; obtaining new information, tools and insights into well-being and productivity at work; and support in identifying essential individual and organizational development needs and starting to proactively work on them. Table 3 describes the benefits of the training reported by the trainees in more detail.

	Enhanced awareness	Development of new practices
Individual level	<ul style="list-style-type: none"> *more aware of one's own general approach to work; e.g. what is a good enough input vs. draining oneself *more aware of one's accustomed role in social interaction and how this affects one's well-being as well as the dynamics of the group *more aware of the choices available regarding one's own work *better understanding of the process of change and more aware of what this requires of people; more lenient towards oneself and others *acknowledging and accepting change and incompleteness as natural and constant elements of life *better understanding of diversity *enhanced awareness of one's own role in influencing coworkers' everyday practices and general well-being 	<ul style="list-style-type: none"> *starting to plan and manage one's own work more systematically and proactively *prioritizing work tasks *starting to actively and consciously reflect on work practices as part of everyday work routine *clarifying and setting boundaries for work, both during the workday and at the interfaces between work and leisure time *starting to take breaks during the workday or generally slow down a little *utilizing new practices in order to work more efficiently and lightly, such as reducing multitasking related to general work practices or using digital devices *deliberately choosing purposeful modes of communication, e.g. reducing unnecessary use of email *actively seeking digital applications that facilitate work and trying them out *supporting and coaching others in their working methods towards ease and efficiency *practicing new leadership skills, in particular in leading change
Organizational level	<ul style="list-style-type: none"> *more aware of the organizational culture at the workplace, e.g. communication practices *more aware of implicit, taken-for-granted ways of working at one's own workplace *more aware of the current state of digital devices and physical spaces and how they should be developed *through the workshops and communication with fellow trainees from other organizations, more aware of different ways in which to arrange work *acknowledgement of each employee's responsibility and role in the organizational change process 	<ul style="list-style-type: none"> *setting up new meeting routines in the work community to actively and collaboratively discuss focal topics that emerged in the training *communicating more explicitly, openly and actively, also inviting questioning of accustomed habits at the workplace *exploring new ways of working and trying them out in practice *introducing useful new digital platforms and deliberately and critically reflecting on the function of each one as well as those already in use *co-designing and agreeing on shared digital strategies and knowledge practices, e.g. the intended purposes and kind of communication of each application *modifying the physical space to better meet work requirements, e.g. increasing the space reserved for quiet work or for taking breaks

Table 3 Trainee-reported changes resulting from training program.

6.3 STUDY III: THE IMPORTANCE OF BROAD SELF-REGULATORY SKILLS IN MULTI-LOCATIONAL KNOWLEDGE WORK – INTRODUCING A NEW QUESTIONNAIRE INSTRUMENT

Study III focused on strategies that are available for and needed by individuals to manage their psychological resources in order to support both productivity and well-being in knowledge work. The study presented an empirical pilot of a scale measuring broad self-regulatory skills in multi-locational knowledge work and tested the measurement model specified according to the theoretical background. In order to start the process of validating the scale, the study also examined its relations to established well-being at work scales, namely work engagement (Schaufeli, Bakker, & Salanova, 2006) and burnout (Feldt et al., 2013; Salmela-Aro et al., 2011).

In the piloting process of the broad self-regulatory skills in multi-locational knowledge work scale, three factors were specified according to the theoretical background: behavioral self-regulation, cognitive-emotional self-regulation and self-regulation regarding recovery. The initial three-factor model (see Figure 2) showed a good fit. All factor loadings were significant and no post-hoc modifications were necessary.

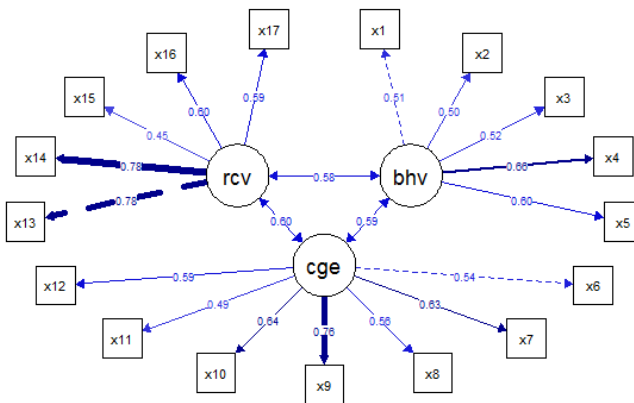


Figure 3 Initial three-factor model specified according to theoretical background: behavioral self-regulation, cognitive-emotional self-regulation and self-regulation regarding recovery.

Prior to settling on the theoretically expected model, the three-factor measurement model for broad self-regulatory skills was compared to a unidimensional one-factor model. The model comparison clearly indicated that a three-factor model would fit the data considerably better than a one-factor model (Sjöblom, Hietajärvi & Salmela-Aro, 2020) (see Table 4). Appendix 2 contains the item level correlation matrix.

Table 4 Confirmatory factor analysis fit statistics and model comparison results.

	χ^2	χ^2_{scaled}	df_{scaled}	p_{scaled}	RMSEA	TLI	CFI	SRMR
m3-factor	170.96	158.61	116	0.005	0.05	0.93	0.94	0.05
m1-factor	328.56	307.22	119	< 0.001	0.09	0.73	0.76	0.08

Model comparison (Satorra – Bentler, 2001)					
	Df	χ^2	$\Delta\chi^2$	Δdf	p
m3-factor	116	170.96			
m1-factor	119	328.56	211.59	3.00	<0.001

The latent variable correlation analyses confirmed the expected and meaningful relations between self-regulation factors and the established well-being at work scales. The latent variable correlations are described in Figures 3 and 4: blue lines indicate positive correlations and red lines negative ones, and the width of the lines corresponds to the absolute value of the correlations: the higher the correlation, the thicker the line (see Epskamp, Cramer, Waldorp, Schmittmann & Borsboom, 2012). A more detailed description of the specific relations between each of the self-regulation factors, work engagement and the three subscales of job burnout (exhaustion, cynicism and inadequacy) can be found in the original article.

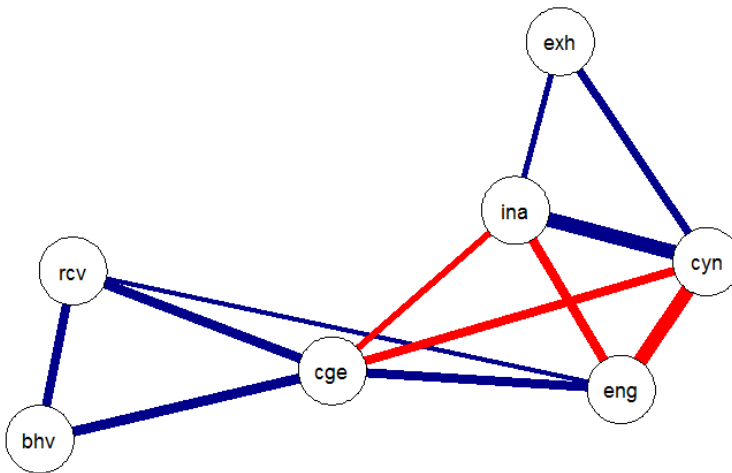


Figure 4 Latent variable zero-order correlations between the self-regulation factors, work engagement and the three subscales of job burnout.

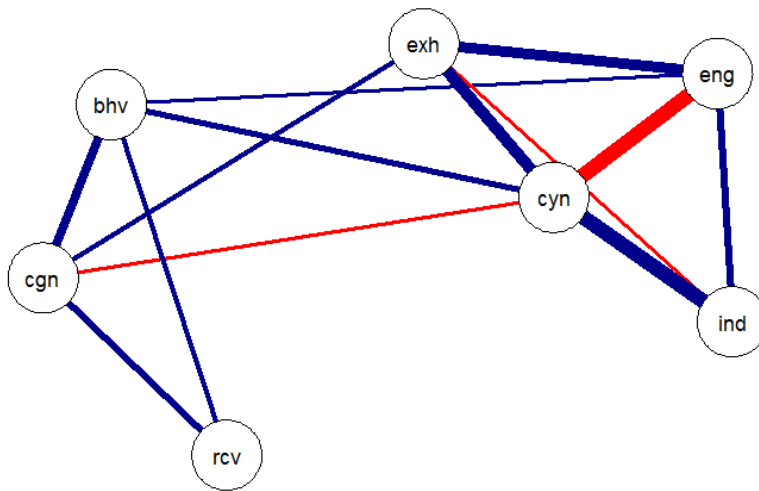


Figure 5 Latent variable partial correlations between the self-regulation factors, work engagement and the three subscales of job burnout.

Overall, the results of Study III implied that this scale is effective for measuring the self-regulatory skills of knowledge workers. The scale needs to be further developed by rephrasing some of the items in a more unambiguous manner, and its results should be confirmed in several representative samples.

7 DISCUSSION

This dissertation aimed to enhance the understanding of the relations between complex multi-locational knowledge work environments and users' productivity and well-being, as well as of how these environments can best be utilized to support these. The general research question of the dissertation was: How can learning, productivity and well-being be supported in modern work and study environments?

The substudies more closely examined the role of the physical environment and modern tools with regard to motivation (I), interventions that can be developed in order to effectively utilize modern spaces and tools as part of human performance (II), skills that individuals need in order to make use of complex environments and tools as part of multi-locational knowledge work, as well as the assessment of these skills (III). Thus, the studies approached the topic from the perspective of theory, intervention and methodology.

A more detailed discussion of the specific results of each of the substudies is presented in each of the original articles. In the following, I discuss the main results of the dissertation as a whole.

7.1 DISCUSSION OF MAIN RESULTS

7.1.1 PHYSICAL ENVIRONMENT AND TOOLS CONTRIBUTE TO BASIC PSYCHOLOGICAL NEEDS AND CONSEQUENTLY TO PRODUCTIVITY AND WELL-BEING

This dissertation built on the present knowledge on the role of the physical environment and tools in human cognition (Hakkarainen, Palonen, Paavola & Lehtinen, 2004; Hutchins, 2001; Norman, 1993; Scardamalia & Bereiter, 2014). In addition, strong scientific evidence supported the view that the social and cultural environment play a substantial part in the satisfaction of basic psychological needs, and consequently have the potential to foster or hinder productivity and well-being as well (Deci & Ryan, 2000; Deci & Ryan, 2014; Ryan & Deci, 2000; Ryan & Deci, 2002; Ryan & Deci, 2017). What had not been studied, however, was the role of physical environments and tools in supporting basic psychological needs and consequently motivation, productivity and well-being. Looking more closely into the role of physical environments and tools in human functioning seemed particularly interesting in regard to present-day knowledge and challenges; the substantial risks and potential of modern environments and tools with regard to productivity and well-being (Bosch-Sijtsema, Ruohomäki & Vartiainen, 2010; Moisala et al., 2016; Vartiainen & Hyrkkänen, 2010; Zijlstra & Sonnentag, 2006).

Study I demonstrated that like social and cultural environments, physical environments can also either support or hinder the fulfillment of basic psychological needs. Physical environments and tools not only influence cognitive functioning but inevitably give rise to an emotional experience as well. For instance, if the physical environment constantly poses a

challenge to context-related activities and because of this, users continuously feel incompetent in the context, this experience builds on their views of themselves acting in that particular environment, and consequently, they may be less likely to frequently and willingly approach the same environment in the future. On the other hand, the physical environment and tools can complement and support the users' competence and autonomy by offering procedural facilitation (Bereiter & Scardamalia, 1987), in which the user is assisted in a task by prompting executive processes rather than directly being assisted with the content of the task (O'Connor & Klein, 2004). The emotional experience resulting from the quality of the concrete activities taking place in the physical space can support or challenge the feeling of being connected to that particular environment, as well as the broader context related to it.

This study partly overlapped with a recent study by Peters, Calvo and Ryan (2018) in the emphasis on the relation between usability and psychological need satisfaction. In their study, Peters, Calvo and Ryan focused on how user interfaces in technology support or undermine basic psychological need satisfaction and presented a model of how to take this into account in technology design. However, the focus of their study was on one hand narrower, in the sense that it focused on technology only and not the physical environment or tools more generally, but on the other hand broader, in the sense that it elaborated on the expansive spheres of experience related to technology: interacting with technology via its *interface*, engaging with technology-enabled *tasks*, overarching technology-supported *behavior*, as part of a user's overall *life* as well as societal well-being (*society*).

Study I also brought together the perspectives of cognition and emotion within the context of research on the role of the physical environment and tools in human functioning. Not only do the environments and tools contribute to the intellectual functioning of the users; they also contribute to the emotional experience of the environment being either supportive or hindering with regard to the users' basic psychological needs. Within the context of learning and motivation, it is already widely acknowledged that cognitive performance and emotions go hand in hand, and in order to support intellectual functioning and productivity it is crucial to also support motivation and emotions (e.g. Deci & Ryan, 2000; Hidi & Renninger, 2006; Mega, Ronconi & De Beni, 2014; Pekrun, Goetz, Titz, & Perry, 2002; Ryan & Deci, 2000). It is time this approach is also introduced to the research on physical environments and our understanding of them.

7.1.2 21ST CENTURY WORKING LIFE SKILLS NEED TO AND CAN BE SUPPORTED IN BOTH THE EDUCATIONAL SYSTEM AND WORKING LIFE

The basis for Study II was the knowledge that present and future working life, as well as functioning in present-day society and the immediate everyday environments in a broader sense, requires new competencies, which are now being included in the curricula of comprehensive schools worldwide (Ananiadou & Claro, 2009). It was known that digitalization, for example, poses extensive potential and risks with regard to productivity and well-being, and individuals need particular skills to use digital technology in beneficial ways (Moisala et al., 2016; Sparks, Faragher & Cooper, 2001; Vartiainen & Hyrkkänen, 2010; Zijlstra & Sonnentag, 2006). The need for new working life competencies is particularly focal in knowledge work,

which has been the trend of working life for many years (Brinkley, 2006; Rüdiger & McVerry, 2007). It was also the specific context and focus of this study.

What was underrepresented in research and applied work was that adults do not have these new competencies as built-in qualities either; like any skills, they need to be deliberately practiced and learned. However, training programs that acknowledge the challenges of complex knowledge work environments and users' productivity and well-being in the light of current multidisciplinary knowledge, and that also address them, have been sparse. The study shed light on the fact that the working population also needs support in responding to these particular challenges of present-day working life, and such support needs to be developed and made available for both individuals and organizations. Previous research has recognized that diverse physical environments and digital tools only determine the quality of an activity through the practices used (Hakkarainen, 2009); however, the academic community has paid less attention to specifically studying what kinds of concrete practices are needed and how these can be supported.

Study II presented a training program that aimed to support well-being and productivity at work by developing the participants' awareness skills and behavioral strategies related to knowledge work, digital tools and physical spaces. It concluded that both individuals and organizations were able to benefit from training in the use of multi-locational spaces and digital tools in ways that support productivity and well-being. The training program succeeded in supporting the development of awareness skills, in offering the participants new information, tools and insights into well-being and productivity at work, and in helping them identify essential individual and organizational development needs and proactively start working on these. The study showed that it is fruitful to offer individuals and organizations support in the form of training programs to help them find proactive ways to manage multi-locational, digitally-mediated knowledge work and the psychological resources available for it.

7.1.3 SUPPORTING PRODUCTIVITY AND WELL-BEING IN PRACTICE: NEW METHOD FOR ASSESSING BROAD SELF-REGULATORY SKILLS IN MULTI-LOCATIONAL KNOWLEDGE WORK

A number of everyday aspects and practices that support productivity and well-being in knowledge work and modern environments could be identified in previous research, such as limiting multi-tasking, job crafting, utilizing emotional intelligence, regulating emotions, and regulating nutrition, exercise, breaks and recovery (e.g. Berto, 2005; Donaldson-Feilder & Bond, 2004; Fredrickson, 2001; Gómez-Pinilla, 2008; Hillman, Erickson & Kramer, 2008; Newman, Joseph & MacCann, 2010; Salo, Salmela, Salmi, Numminen & Alho, 2017; Scholey, Harper & Kennedy, 2001; Williams, 2017; Wrzesniewski & Dutton, 2001; Zacher, Brailsford & Parker, 2014). Indeed, as explained in the previous section, many novel skills and practices are essential for employees in present-day working life to function productively and sustainably (Ananiadou & Claro, 2009; Lonka, 2018; Sparks, Faragher & Cooper, 2001). One of these skills is self-regulation: Modern environments set increasing demands for employees to manage their own work, well-being and the available psychological resources.

Despite the aforementioned knowledge, rather surprisingly, measures for studying the various ways in which employees proactively regulate their resources have been lacking. One of the core conclusions of Study II was that current working life requires particular new skills of employees; thus, as a consequent need, measures for assessing such skills also need to be developed. Study III aimed to develop a scale to measure multi-locational knowledge workers' self-regulatory skills related to productivity and well-being. The purpose of the study was to offer a means to assess the individual state of required skills as well as to locate possible developmental needs for these skills.

Study III showed promising results that imply that this scale is effective in measuring the self-regulatory skills of knowledge workers. It is important to point out, however, that in order to confirm the results of this pilot study, the study needs to be repeated with a more representative sample. Overall, Study III offered new understanding of the specific challenges of knowledge intensive, digitally-mediated work, as well as a practical tool for measuring knowledge workers' self-regulatory skills related to productivity and well-being. It contributed by operationalizing the topical questions of how to assess and support proactive employee functioning in increasingly complex physical, digital and social surroundings.

7.1.4 HOW CAN LEARNING, PRODUCTIVITY AND WELL-BEING BE SUPPORTED IN MODERN WORK AND STUDY ENVIRONMENTS?

To conclude the main results of the dissertation, let us go back to the general research question of the dissertation study: How can learning, productivity and well-being be supported in modern work and study environments? This dissertation contributed to answering this broad question by looking into specific areas of theory, intervention and methodology.

The dissertation concludes that physical environments and tools contribute to the fulfillment of basic psychological needs, that individuals and organizations can and need to benefit from support in using multi-locational spaces and digital tools in effective ways, and that new methods for assessing the 21st century skills and proactive practices of employees need to and can be developed.

The main results of the substudies are also closely interrelated (Figure 6). In order to support human functioning in modern work and study environments, we first need to recognize and understand the effect of physical environments and tools on it (Study I). As noted in the main result of Study I, in addition to the environment and tools actually enabling or hindering a certain intellectual activity, the way in which the individual is able to function in a given physical environment also bears importance with regard to motivation and well-being. Consequently, in order to function effectively, individuals and communities need to be sufficiently supported in learning the required skills related to modern environments and applying them both individually and collaboratively (Study II). In addition, in order to locate possible developmental needs and to provide sufficient support, means to assess the level of these skills are also required (Study III).

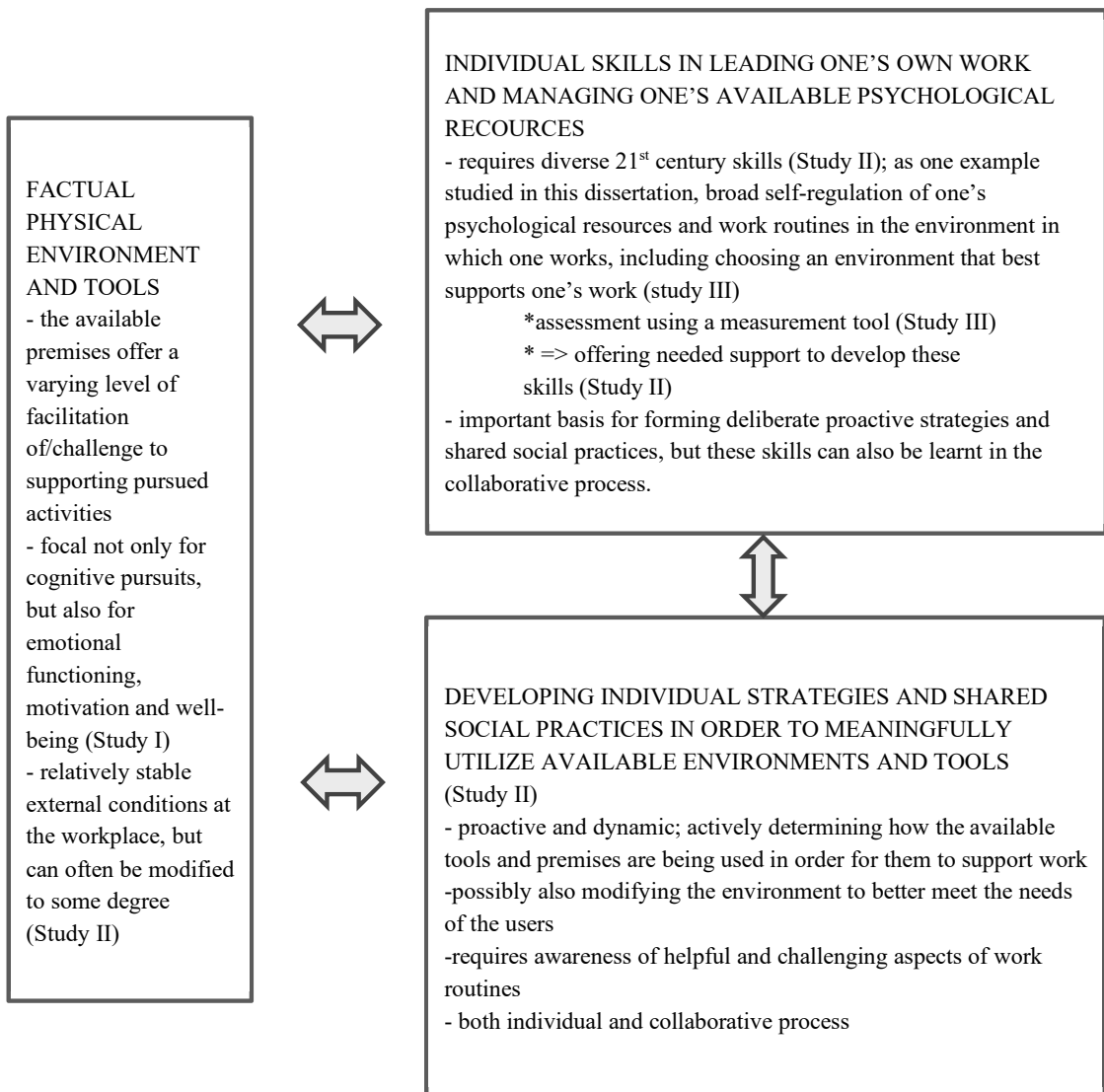


Figure 6 Elements supporting/challenging productivity and well-being in modern, digitally-mediated knowledge work environments.

Next, I discuss the implications of the dissertation as well as its strengths and limitations in more detail.

7.2 IMPLICATIONS

7.2.1 IMPLICATIONS FOR RESEARCH

The results of this dissertation provide theoretical value for understanding the role of the physical environment as part of human functioning. They combine multidisciplinary knowledge and contribute to the current understanding of how to utilize multi-locational spaces and digital tools in ways that support the productivity and well-being of employees.

The physical environment represents a novel context for the application of self-determination theory (Deci & Ryan, 1985; Deci & Ryan, 2000; Ryan & Deci, 2000; Ryan & Deci, 2017). According to Study I, like the social and cultural environment, the physical environment can also support or hinder the fulfillment of basic psychological needs. However, Study I can be seen as an opening to an unexplored area, and it is important to further deepen and validate its results. Study I approached the topic in a study context, using qualitative methodology, an abductive approach (Graneheim, Lindgren & Lundman, 2017) and a relatively small sample. Future research calls for specific research settings in order to more precisely study the question of physical environment and basic psychological needs, more representative samples, and varied methodologies to obtain a more comprehensive picture of the topic.

Study I also demonstrated the importance of the physical environment for intellectual and emotional functioning. Even though the intellectual functioning of an individual is often seen as an activity solely occurring within the person, it is always nested in a given physical environment, even when the work is carried out in a virtual environment. In fact, the characteristics of modern multi-locational knowledge work may lead people to think that work is not tied to the environment in any way. However, although it is not tied to a specific time and place as such, it is greatly influenced by a number of things in a given environment and tools (e.g. Haapakangas, Hongisto, Varjo & Lahtinen, 2018; Hutchins, 2001; Koroma, Hyrkkänen & Vartiainen, 2014; Moisala et al., 2016; Olson & Olson, 2000; Powell, Piccoli & Ives, 2004; Vartiainen & Hyrkkänen, 2010). Naturally, in the same way as the individual is not separate from the physical environment, the physical environment is not a separate entity but is embedded in the social environment and the culture of the community using the spaces and tools (e.g. Hakkarainen, 2009; Mälkki, Sjöblom & Lonka, 2014; Nenonen et al., 2009).

Study III, for its part, aimed to contribute to the measures available for assessing proactive employee behavior related to the new characteristics of work, environments and tools, namely self-regulation in the context of multi-locational knowledge work. Interestingly, although positive psychology has been a growing area of research in different contexts (Donaldson & Ko, 2010; Gable & Haidt, 2005), and specifically aims to study the ways in which the thriving of individuals and groups can be supported, it appears that the development of methods for assessing the related behaviors lag behind it. Study III, for instance, originated from a practical need recognized in Study II for a scale to measure skills and strategies that employees utilize in order to manage and support the psychological resources they have available for the work. The readily available, scientifically established scales related to well-being and productivity at work focused on deeper, more long-term and partly more severe phenomena, such as work engagement, job burnout or workaholism.

Study III also brought up, yet again, the question of the co-occurrence of positive and negative work life phenomena (for similar results, see Bakker, Albrecht & Leiter, 2011a; Bakker, Albrecht & Leiter, 2011b; for similar results in the context of education see e.g. Salmela-Aro, 2017; Salmela-Aro & Read, 2017), namely in the positive relations between the cognitive-emotional self-regulation factor and both work engagement and cynicism. This is a topic that would deserve more dedicated research – if it is common for engagement to co-occur with a psychologically or physically draining approach to work or even burnout, what can be done about it, and how can balanced work engagement be supported? One possible approach is to recognize that, in line with the demands-resources model (Bakker & Demerouti, 2006; Upadaya & Salmela-Aro, 2013), when the demands of the task are high, it is essential to also have enough resources to provide the needed support (Salmela-Aro, 2017; Salmela-Aro & Read, 2017). In the context of this dissertation study, one example of such resources is support for recognizing and managing the challenging and helpful aspects of everyday work, for example, in the form of a training program, as presented in Study II. Tools such as the scale presented in Study III are also focal in assessing the areas in which support and additional resources are needed.

As a related finding, on the other hand, the results of Study III interestingly indicated that self-regulation regarding recovery was, in fact, related to work engagement only. Although no definitive conclusions can be made on the basis of correlational analyses and cross-sectional data, this result may imply that engaged employees also actively take care of their well-being and build their work on a sustainable basis. From the perspective of scientific research, a large body of evidence states that sustainable productivity, motivation and creative thinking also require sufficient rest (e.g. Amabile, 1998; Mann & Cadman, 2014; Zacher, Brailsford & Parker, 2014; Zijlstra & Sonnentag, 2006). The work culture may play a part in this picture – engagement does not need to jeopardize a balanced approach to work by default; but in working life, the culture may sometimes suggest that engagement cannot co-exist with setting boundaries for work or overachieving being the norm (e.g. on Finland, Hyvärinen, 2019). Future research will hopefully tap into these dynamics more closely.

7.2.2 PRACTICAL IMPLICATIONS

Firstly, the results of the dissertation show that it is crucial to pay more attention to the physical environment in which the activity takes place. According to the results of Study I, learning and well-being can be facilitated by developing physical environments that support basic psychological needs. The use of psychological and pedagogical knowledge is essential when designing or renovating work and learning environments in order to make full use of the potential of physical environments as part of human performance. For instance, users should be provided with suitable spaces and tools for the activities taking place, as well as an appropriate balance of guidance and autonomy in using them. Special attention should be paid to the functionality of the physical environment and tools, as the experience of a physical environment is built through the activity performed in the environment.

In regard to the physical environment, Study II showed that the design and functionality of physical spaces was closely related to the organizational culture. Consequently, work

environments seemed polarized in the types of work tasks they primarily accommodated, although work in all organizations included similar sub-tasks, such as collaborative work or quiet individual work. It would be important that all work environments be less polarized and more diverse in terms of the facilities that they provide and the activities that they support, so that they could offer their employees sufficient spaces for the different kinds of work tasks that they must perform as part of their work.

Secondly, more attention needs to be paid to developing the competencies and practices required for modern environments and tools, on both the individual and organizational level, and this requires a conscious focus and effort. Twenty-first century skills, such as self-regulation, cognitive load management, and the ability to collaborate in networked systems and use digital tools are needed not only in schools but also in working life. The results of Study II show that training programs can successfully support the development of the competencies needed. Although the main emphasis in this dissertation was on the individual perspective, the role of the organization and community in enabling, co-creating and supporting useful and beneficial practices should not be underestimated.

It is important to further develop materials and evidence-based training in order to provide the support needed as well as to consider how to make it as accessible as possible. Developing effective new practices and consciously choosing to maintain existing ones that work well first requires awareness of the current situation to enable the identification of focal needs. Second, it requires information and tools for beneficial practices, and third, often also support for the development process. In the midst of daily stress and the abundance of tasks and stimuli, it is often challenging to clearly see what is essential, what needs to change and what does not, and how to make the required changes. Although modern knowledge-intensive, digitally-mediated work comes with its specific challenges and although there is currently extensive knowledge on helpful and challenging aspects of this, interventions and training programs addressing these issues have been sparse. The training program developed in Study II responded to these challenges and opened up new grounds for further elaboration and development in this area.

Contrary to schooling systems, in working life it is challenging to offer support that would cover a larger working population. The organizations are likely to be heterogeneous or even polarized with regard to the support that they offer their employees. Thus, information on the importance of the actions to support employees in the ways described in this dissertation should be made even more visible in society. Psychoeducation on what affects cognitive functioning and well-being, as well as practical guidelines on how this can be taken into account, would be highly beneficial on both individual and organizational levels. As a small step related to this dissertation and more specifically to Study II, some materials developed in the “3SPACES – Towards Inspiring Workplaces” project funded by the European Social Fund have been made freely accessible online (Sipilä, Starck & Wegmuller, 2017; Starck, Sjöblom, Sipilä, Lammassaari, Åberg & Lehtinen-Toivola, 2017).

Finally, the importance in knowledge work of small everyday actions and practices related to well-being and productivity should not be underestimated. The potential risks of modern environments and tools are not minor issues; they affect people and their health and productivity worldwide, on a daily basis (Helliwell, Layard & Sachs, 2019; Sparks, Faragher & Cooper, 2001; WHO, 2013;). Although it represents a more extreme and prolonged problem

caused by work, burnout is shockingly prevalent in the Finnish population (Koskinen, Lundqvist & Ristiluoma, 2012), and in general, sick leaves due to mental health issues are on the rise (Blomgren, 2019). Besides causing severe human suffering, mental health issues and burnout also cause major costs to society every year – the OECD estimates that in Finland the costs of mental health-related issues make up 5.3% of the country's GDP (OECD/EU, 2018). Thus, developing seemingly small practices of everyday well-being and productivity could actually be a form of preventative work concerning mental health, as well as substantial support for GDP.

7.3 STRENGTHS AND LIMITATIONS

This dissertation brings together the research traditions of motivational psychology, educational psychology, work and organizational psychology and occupational health research in order to fully utilize existing multidisciplinary knowledge to gain a deeper, more multidimensional understanding of the phenomena under study. It contributes to areas that current research has neglected: examining the role of the physical environment in supporting basic psychological needs and motivation; developing programs for organizations and individuals in order for them to utilize modern environments and tools to support productivity and well-being; and developing measurement tools to assess the specific new competencies required by current working life and knowledge work in particular. The latter two studies are also closely related to 21st century working life skills, which, surprisingly, have not been emphasized as much as the need to teach these skills in comprehensive schools.

The dissertation included substudies from both the education and work context, which was both a strength and limitation: a limitation as the data were not consistently from the same context, but a strength as this enriched the understanding of the topic by drawing from both contexts. As mentioned in Section 2.1, knowledge work is increasingly learning work and knowledge-intensive organizations are becoming learning organizations: The worlds of education and work are moving closer together. Learning at the workplace, integrating both formal and informal learning, is an essential prerequisite for developing the kind of expertise needed in current working life (Tynjälä, 2008). Thus it can be argued that combining research from both the education and work contexts actually added value to the dissertation.

In addition to its research focus, this dissertation aimed to respond to current working life needs, in particular those of productive and sustainable work, by developing practical tools for both individuals and organizations in the form of a training program and questionnaire instrument. The knowledge produced in this dissertation can also be utilized when designing new work environments or learning environments or renovating old ones to better support and meet the needs of users.

In terms of the limitations of the dissertation, a few methodological issues need to be pointed out. The samples of the substudies were limited, not only in terms of the number of participants, but also in the kinds of populations they represented. Thus, it would be highly beneficial to confirm the results with more representative samples.

In Study I, the methodological approach was qualitative and abductive. This served to effectively examine a new area of research, but as noted in Section 7.2.1, in the future, methodological diversity, as well as more representative samples, are needed for a more comprehensive understanding of the topic. Due to extensive research on basic psychological needs, numerous questionnaires are currently available for measuring basic psychological need satisfaction in different contexts. It would be worthwhile to also develop a questionnaire that measures basic psychological need satisfaction in the context of the physical environment and tools.

With regard to Study II, in order to make the support as efficient and accessible as possible, it would be very useful to further differentiate the parts of the training that are particularly helpful with regard to the beneficial results of the program, and the ones that are perhaps less essential. Based on a more detailed focus, it would be useful to produce a more extensive set of materials to be used in organizations or by individuals. As mentioned earlier in the text, some of the material is already openly available (Sipilä, Starck & Wegmuller, 2017; Starck, Sjöblom, Sipilä, Lammassaari, Åberg & Lehtinen-Toivola, 2017). The Finnish Centre for Economic Development, Transport and the Environment also chose to communicate information on the project on a national level, as the project and the results were regarded as having application value beyond the project itself.

Finally, Study III contributed by piloting a new scale on a topical issue, but its results need to be further validated with larger and more representative samples. A sufficiently representative sample would enable determination of the distribution and reference values and thus allow more precise conclusions to be made on individual responses to the questionnaire. It is also important to note that in addition to self-regulation, co-regulation and shared regulation are also central in the context of knowledge work (Miller, Järvelä & Hadwin, 2017). Moreover, in line with the ideas of distributed cognition and affordances (e.g. Gibson, 1977; Hakkarainen, Palonen, Paavola & Lehtinen, 2004; Hutchins, 2001; Norman, 1993), regulation of the physical environment can also be seen as a two-way process: the user can utilize different kinds of environments to regulate their activities (see also Korpela, 2012), but the environment also nudges the individual in a particular direction and to a certain degree determines the choices available. Perhaps future research will be able to combine measures of different areas of regulation for a more comprehensive picture of regulation in knowledge work.

As mentioned in the introduction, this dissertation was limited to approaching the research topics from the psychological perspective. However, the responsibility for productivity, well-being and sustainability cannot be imposed on the employee alone: Although individual choices and proactivity are highly important and influential, a number of workplace factors determine employee productivity and well-being beyond their own control. In addition, it is also important to recognize and point out that many societal factors also play a significant role in the current challenges faced in working life (e.g. Dufva, Halonen, Kari, Koivisto, Koivisto & Myllyoja, 2017). The results of this dissertation can only be applied in the individual and organizational context, and various social policies remain highly influential with regard to the options that are available to individuals and organizations. For example, this dissertation shed light on the need for supporting 21st century skills not only in comprehensive schools but also in working life; however, actually arranging sufficient support is to a large part a broader societal question.

Along with developing individuals' and organizations' abilities to respond to the current challenges of working life, the importance of societal policies in supporting well-being and sustainability in today's working life should also be recognized and further studied.

7.4 CONCLUDING REMARKS

This dissertation utilized multidisciplinary knowledge and applied mixed methods to shed light on the topical questions of how to support productivity, well-being and sustainability in current working life. It offered new theoretical input and operationalized questions on how to assess and support proactive employee functioning in increasingly complex physical, digital and social surroundings.

Individuals' cognitive potential is the most important and valuable resource not only in knowledge intensive organizations but also in modern societies. As an increasing number of employees work in the field of knowledge-intensive work and their input is needed for solving complex problems, it is becoming essential to understand how psychological resources can be supported and to develop ways of putting that into practice. Eventually, success in this kind of work, from both the individual and organizational perspective, will essentially require fostering the thriving of human potential in a way that recognizes the importance of both productivity and sustainability.

REFERENCES

- Amabile, T. M. (1998). *How to kill creativity*. Boston, MA: Harvard Business School Publishing.
- Ananiadou, K., & Claro, M. (2009). *21st century skills and competences for new millennium learners in OECD countries*. OECD Education Working Papers, No. 41. Paris: OECD Publishing.
- Bakker, A. B., Albrecht, S. L., & Leiter, M. P. (2011a). Key questions regarding work engagement. *European Journal of Work and Organizational Psychology, 20*(1), 4–28.
- Bakker, A. B., Albrecht, S. L., & Leiter, M. P. (2011b). Work engagement: Further reflections on the state of play. *European Journal of Work and Organizational Psychology, 20*(1), 74–88.
- Bakker, A. B., & Demerouti, E. (2006). The job demands-resources model: State of art. *Journal of Managerial Psychology, 22*(3), 309–328.
- Bechtel, R. B., & Churchman, A. (Eds.), (2003). *Handbook of environmental psychology*. Hoboken, NJ: John Wiley & Sons.
- Bereiter, C., & Scardamalia, M. (1987). *The psychology of written composition*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology, 25*(3), 249–259.
- Blomgren, J. (2019, January 25). Sairauspoissaolojen kasvu jatkuu – mielenterveyden häiriöt yhä suurempana huolenaiheena [Sick leaves continue to increase – Mental health problems are an ever growing concern] [Research blog by Kela – the Social Insurance Institution of Finland]. Retrieved from <http://tutkimusblogi.kela.fi/arkisto/4792>
- Boekaerts, M., Zeidner, M., & Pintrich, P. R. (Eds.), (2000). *Handbook of self-regulation*. Amsterdam: Elsevier.
- Bosch-Sijtsema, P., Fruchter, R., Vartiainen, M., & Ruohomäki, V. (2011). Challenging new ways of working for remote managers in global collaborative work environments. In C. Kelliher, & J. Richardson (Eds.), *New ways of organizing work. Developments, perspectives, and experiences* (pp. 160–175). New York: Routledge.
- Bosch-Sijtsema, P. M., Ruohomäki, V., & Vartiainen, M. (2009). Knowledge work productivity in distributed teams. *Journal of Knowledge Management, 13*(6), 533–546.
- Bosch-Sijtsema, P. M., Ruohomäki, V., & Vartiainen, M. (2010). Multi-locational knowledge workers in the office: navigation, disturbances and effectiveness. *New Technology, Work and Employment, 25*(3), 183–195.
- Boutellier, R., Ullman, F., Schreiber, J., & Naef, R. (2008). Impact of office layout on communication in a science-driven business. *R&D Management, 38*(4), 372–391.
- Brinkley, I. (2006). *Defining the knowledge economy*. London: The work foundation.
- Chinowsky, P., & Carrillo, P. (2007). Knowledge management to learning organization connection. *Journal of Management in Engineering, 23*(3), 122–130.
- Chirkov, V., Ryan, R. M., Kim, Y., & Kaplan, U. (2003). Differentiating autonomy from individualism and independence: A self-determination theory perspective on internalization of cultural orientations and well-being. *Journal of Personality and Social Psychology, 84*(1), 97–110.
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum.
- Deci, E. L., & Ryan, R. M. (2000). “The ”what” and ”why” of goal pursuits: human needs and the self-determination of behavior. *Psychological Inquiry, 11*, 227–268.

- Deci, E., and Ryan, R. (2014). The importance of universal psychological needs for understanding motivation in the workplace. In M. Gagné (Ed.), *The Oxford handbook of work engagement, motivation, and self-determination theory* (pp. 13–32). Oxford, UK: Oxford Library of Psychology.
- Deci, E. L., Ryan, R. M., Gagné, M., Leone, D. R., Usunov, J., & Kornazheva, B. P. (2001). Need satisfaction, motivation, and well-being in the work organizations of a former Eastern Bloc country: A cross-cultural study of self-determination. *Personality and Social Psychology Bulletin*, 27(8), 930–942.
- De Paoli, D. (2015). Virtual organizations: a call for new leadership. In A. Ropo, P. Salovaara, E. Sauer, & D. De Paoli (Eds.), *Leadership in spaces and places*, (pp. 109–127). Cheltenham, UK: Edward Elgar Publishing.
- Dominique, J. F., Roozendaal, B., Nitsch, R. M., McGaugh, J. L., & Hock, C. (2000). Acute cortisone administration impairs retrieval of long-term declarative memory in humans. *Nature Neuroscience*, 3(4), 313.
- Donaldson-Feilder, E. J., & Bond, F. W. (2004). The relative importance of psychological acceptance and emotional intelligence to workplace well-being. *British Journal of Guidance and Counselling*, 32(2), 187–203.
- Donaldson, S. I., & Ko, I. (2010). Positive organizational psychology, behavior, and scholarship: A review of the emerging literature and evidence base. *The Journal of Positive Psychology*, 5(3), 177–191.
- Dufva, M., Halonen, M., Kari, M., Koivisto, T., Koivisto, R., & Myllyoja, J. (2017). *Kohti jaettua ymmärrystä työn tulevaisuudesta* [Towards a shared understanding on the future of work]. Helsinki: Valtioneuvoston kanslia – Prime Minister’s Office.
- Edelson, D. C. (2002). Design research: What we learn when we engage in design. *The Journal of the Learning Sciences*, 11(1), 105–121.
- El-Farr, H. K. (2009). Knowledge work and workers: A critical literature review. *Leed University Business School, Working Paper Series*, 1(1), 1–15.
- Epskamp, S., Cramer, A. O., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network visualizations of relationships in psychometric data. *Journal of Statistical Software*, 48(4), 1–18.
- Feldt, T., Rantanen, J., Hyvönen, K., Mäkikangas, A., Huhtala, M., Pihlajasaari, P., & Kinnunen, U. (2013). The 9-item Bergen burnout inventory: Factorial validity across organisations and measurements of longitudinal data. *Industrial Health*. Retrieved from https://www.jstage.jst.go.jp/article/indhealth/advpub/o/advpub_2013-0059/_pdf
- Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, 56(3), 218–226.
- Gable, S. L., & Haidt, J. (2005). What (and why) is positive psychology? *Review of General Psychology*, 9(2), 103–110.
- Gareis, K. (2003). Home-based vs. mobile telework: the interrelationship between different types of telework. In B. Rapp, & P. Jackson (Eds.), *Organization and work beyond 2000* (pp. 171–185). Berlin, Germany: Springer Science and Business Media.
- Gareis, K., Lilischkis, S., & Mentrup, A. (2006). Mapping the mobile eWorkforce in Europe. In J. H. E. Andriessen, & M. Vartiainen (Eds.), *Mobile virtual work - A new paradigm?* (pp. 45–69). Heidelberg, Germany: Springer.
- Gibson, J.J. (1977). The Theory of Affordances. In R. Shaw, & J. Bransford (Eds.) *Perceiving, acting, and knowing. Toward an ecological psychology* (pp. 67–82). Hillsdale: NJ, Lawrence Erlbaum Associates.
- Gómez-Pinilla, F. (2008). Brain foods: the effects of nutrients on brain function. *Nature Reviews Neuroscience*, 9(7), 568–578.

- Graneheim, U. H., Lindgren, B. M., & Lundman, B. (2017). Methodological challenges in qualitative content analysis: A discussion paper. *Nurse Education Today*, 56, 29–34.
- Guthridge, M., Komm, A. B., & Lawson, E. (2008). Making talent a strategic priority. *McKinsey Quarterly*, 1, 49–59.
- Haapakangas, A., Hongisto, V., Varjo, J., & Lahtinen, M. (2018). Benefits of quiet workspaces in open-plan offices – Evidence from two office relocations. *Journal of Environmental Psychology*, 56, 63–75.
- Hakanen, J. (2004). *Työuupumuksesta työn imuun – työhyvinvointitutkimuksen ytimessä ja reuna-alueilla* [From burnout to work engagement: In the core and on the fringes of work-related well-being]. Helsinki: Työterveyslaitos – Finnish Institute of Occupational Health.
- Hakanen, J. (2018). *Työn imu* [Work engagement]. Helsinki: Työterveyslaitos – Finnish Institute of Occupational Health.
- Hakkarainen, K. (2009). A knowledge-practice perspective on technology-mediated learning. *Computer-Supported Collaborative Learning*, 4, 213–231.
- Hakkarainen, K., Palonen, T., Paavola, S., & Lehtinen, E. (2004). *communities of networked expertise: Professional and educational perspectives*. Bingley, UK: Emerald Group Publishing Limited.
- Harrison, A., Wheeler, P., & Whitehead, C. (2004). *The distributed workplace: Sustainable work environments*. London: Routledge.
- Helliwell, J., Layard, R., & Sachs, J. (2019). *World happiness report 2019*. New York: Sustainable Development Solutions Network.
- Hidi, S., & Renninger, K.A. (2006). The four-phase model of interest development. *Educational Psychologist*, 41, 111–127.
- Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: exercise effects on brain and cognition. *Nature Reviews Neuroscience*, 9(1), 58.
- Hislop, D., & Axtell, C. (2009). To infinity and beyond? Workspace and the multi-location worker. *New Technology, Work and Employment*, 24(1), 60–75.
- Hutchins, E. (2001). Distributed cognition. In N. J. Smelser, & P. B. Baltes (Eds.), *International Encyclopedia of the Social and Behavioural Sciences* (pp. 2068–2072). Amsterdam: Elsevier.
- Hyvärinen, H. (2019, April 10). Joka neljäs työntekijä uupuu – onko työuupumus uusi normaali? [Every fourth employee experiences burnout – Is burnout the new normal?] [Tampereen korkeakouluyhteisön lehti Unit – Unit – journal of Tampere higher education community]. Retrieved from <https://www.tuni.fi/unit-magazine/artikkelit/joka-neljas-tyontekija-uupuu-onko-tyouupumus-uusi-normaali>
- Ilardi, B. C., Leone, D., Kasser, R., & Ryan, R. M. (1993). Employee and supervisor ratings of motivation: Main effects and discrepancies associated with job satisfaction and adjustment in a factory setting. *Journal of Applied Social Psychology*, 23, 1789–1805.
- Joffe, H., & Yardley, L. (2004). Content and thematic analysis. In D. F. Marks, & L. Yardley (Eds.), *Research methods for clinical and health psychology* (pp. 56–68). Thousand Oaks, CA: Sage Publishing Ltd.
- Miller, M., Järvelä, S., & Hadwin, A. (2017). Self-regulation, co-regulation, and shared regulation in collaborative learning environments. In D. H. Schunk, & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 99–122). New York, NY: Routledge.
- Kauhanen, A. (2014). *Tulevaisuuden työmarkkinat* [Future labor market]. ETLA Reports No 30. Helsinki: Elinkeinoelämän Tutkimuslaitos – The Research Institute of the Finnish Economy. Retrieved from <http://pub.etla.fi/ETLA-Raportit-Reports-30.pdf>

- Kasser, T., Davey, J., & Ryan, R. M. (1992). Motivation, dependability, and employee-supervisor discrepancies in psychiatric vocational rehabilitation settings. *Rehabilitation Psychology, 37*, 175–187.
- Killgore, W. D. (2010). Effects of sleep deprivation on cognition. *Progress in Brain Research, 185*, 105–129. Elsevier.
- Kirschbaum, C., Wolf, O. T., May, M., Wippich, W., & Hellhammer, D. H. (1996). Stress-and treatment-induced elevations of cortisol levels associated with impaired declarative memory in healthy adults. *Life Sciences, 58*(17), 1475–1483.
- Koroma, J., Hyrkkänen, U., & Vartiainen, M. (2014). Looking for people, places and connections: hindrances when working in multiple locations: a review. *New Technology, Work and Employment, 29*(2), 139–159.
- Korpela, K. (2012). *Developing the Environmental Self-Regulation Hypothesis: Self-regulation and restorative experiences in favorite places*. Riga: LAP LAMBERT Academic Publishing.
- Korpela, K., De Bloom, J., Sianoja, M., Pasanen, T., & Kinnunen, U. (2017). Nature at home and at work: Naturally good? Links between window views, indoor plants, outdoor activities and employee well-being over one year. *Landscape and Urban Planning, 160*, 38–47.
- Korpela, K., Nummi, T., Lipiäinen, L., De Bloom, J., Sianoja, M., Pasanen, T., & Kinnunen, U. (2017). Nature exposure predicts well-being trajectory groups among employees across two years. *Journal of Environmental Psychology, 52*, 81–91.
- Koskinen, S., Lundqvist, A., & Ristiluoma, N. (Eds.), (2012). *Terveys, toimintakyky ja hyvinvointi Suomessa 2011* [Health, performance and well-being in Finland]. Helsinki: Terveyden ja hyvinvoinnin laitos (THL) – The National Institute for Health and Welfare. Retrieved from https://www.julkari.fi/bitstream/handle/10024/90832/Rap068_2012_netti.pdf
- Landy, F. J., & Conte, J. M. (2016). *Work in the 21st century: An introduction to industrial and organizational psychology*. Hoboken, NJ: John Wiley & Sons.
- LeBlanc, V.R. (2009). The effects of acute stress on performance: Implications for health professions education. *Academic Medicine, 84*(10), 25–33.
- Liamputtong, P., & Serry, T. (2013). Making sense of qualitative data. In P. Liamputtong (Ed.), *Research methods in health: Foundations for evidence-based practice* (pp. 365–379). Melbourne: Oxford University Press.
- Lonka, K. and Mind the Gap Research Group (2015). Working document I. In European Parliament (Ed.), *Innovative schools: Teaching and learning in the digital era – Workshop documentation* (pp. 5–46). Brussels: European Parliament.
- Lonka, K. (2018). *Phenomenal learning from Finland*. Helsinki: Edita Publishing.
- Lonka, K., Ketonen, E., Marttinen, K., & Talvio, M. (2019). Engaging leadership training – fostering social interaction skills through e-learning and blended solutions. *Eesti Haridusteaduste Ajakiri, 7*(1), 54–75.
- Mann, S., & Cadman, R. (2014). Does being bored make us more creative? *Creativity Research Journal, 26*(2), 165–173.
- Maslach, C., Schaufeli, W. B., & Leiter, M.P. (2001). Job burnout. *Annual Review of Psychology, 52*, 397–422.
- McEwen, B. S., & Sapolsky, R. M. (1995). Stress and cognitive function. *Current Opinion in Neurobiology, 5*(2), 205–216.
- Mega, C., Ronconi, L., & De Beni, R. (2014). What makes a good student? How emotions, self-regulated learning, and motivation contribute to academic achievement. *Journal of Educational Psychology, 106*(1), 121–131.

- Moisala, M., Salmela, V., Hietajärvi, L., Salo, E., Carlson, S., Salonen, O., Lonka, K., Hakkarainen, K., Salmela-Aro, K., & Alho, K. (2016). Media multitasking is associated with distractibility and increased prefrontal activity in adolescents and young adults. *NeuroImage*, *134*, 113–121.
- Morgan, J. (2016, June 7). Say goodbye to knowledge workers and welcome to learning workers [Forbes article]. Retrieved from https://www.forbes.com/sites/jacobmorgan/2016/06/07/say-goodbye-to-knowledge-workers-and-welcome-to-learning-workers/?_ga=2.20092922.391773860.1559203815-448196036.1558934676#49b0703e2f93
- Mälkki, K., Sjöblom, K., & Lonka, K. (2014). Transformation of the physical space and transformation of the subject. In A. Nicolaidis, & D. Holt (Eds.), *Spaces of transformation and transformation of space: Proceedings of the XI International Transformative Learning Conference* (pp. 550–556). New York, NY: Teachers College, Columbia University.
- National Advisory Board on Research Ethics (2009). *Ethical principles of research in the humanities and social and behavioural sciences and proposals for ethical review*. Helsinki: National Advisory Board on Research Ethics. Retrieved from <https://www.tenk.fi/sites/tenk.fi/files/ethicalprinciples.pdf>
- Nenonen, S., Airo, K., Bosch, P., Fruchter, R., Koivisto, S., Gersberg, N., Rothe, P., Ruohomäki, V., & Vartiainen, M. (2009). *Managing workplace resources for knowledge work*. ProWork project report. Retrieved from https://s3.amazonaws.com/academia.edu.documents/46947699/proworkfinalreport.pdf?response-content-disposition=inline%3B%20filename%3DManaging_Workplace_Resources_for_Knowled.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20191126%2Fus-east-1%2Ffs3%2Faws4_request&X-Amz-Date=20191126T095331Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=74594a107f75fa61fb9ca1cd6e47a33cec287fecbacof2fd6446650516cec299
- Nenonen, S., Kärnä, S., Junnonen, J. M., Tähtinen, S., Sandström, N., Airo, K., & Niemi, O. (Eds.), (2015). *How to co-create campus?* Tampere: Juvenes Print.
- Newman, D. A., Joseph, D. L., & MacCann, C. (2010). Emotional intelligence and job performance: The importance of emotion regulation and emotional labor context. *Industrial and Organizational Psychology*, *3*(2), 159–164.
- Norman, D. A. (1993). *Things that make us smart: Defending human attributes in the age of the machine*. Cambridge, MA: Perseus Books.
- O'Connor, I. M., & Klein, P. D. (2004). Exploration of strategies for facilitating the reading comprehension of high-functioning students with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *34*(2), 115–127.
- OECD/EU (2018). *Health at a glance: Europe 2018 - State of health in the EU cycle*. Paris: OECD Publishing. Retrieved from https://doi.org/10.1787/health_glance_eur-2018-en.
- Ojala, S., & Pyöriä, P. (2018). Mobile knowledge workers and traditional mobile workers: Assessing the prevalence of multi-locational work in Europe. *Acta Sociologica*, *61*(4), 402–418.
- Olson, G. M., & Olson, J. S. (2000). Distance matters. *Human-Computer Interaction*, *15*(2-3), 139–178.
- Parsons, R. and Hartig, T. (2000). Environmental psychophysiology. In J. T. Cacioppo, L. G. Tassinary, & G. Berntson (Eds.), *Handbook of psychophysiology* (pp. 815–846). New York, NY: Cambridge University Press.
- Pashler, H. (1994). Dual-task interference in simple tasks: data and theory. *Psychological Bulletin*, *116*(2), 220.

- Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational Psychologist, 37*(2), 91–105.
- Peters, D., Calvo, R. A., & Ryan, R. M. (2018). Designing for motivation, engagement and well-being in digital experience. *Frontiers in Psychology, 9*, 797.
- Powell, A., Piccoli, G., & Ives, B. (2004). Virtual teams: A review of current literature and directions for future research. *ACM SIGMIS Database: the DATABASE for Advances in Information systems, 35*(1), 6–36.
- Rae, D. E., Stephenson, K. J., & Roden, L. C. (2015). Factors to consider when assessing diurnal variation in sports performance: The influence of chronotype and habitual training time-of-day. *European Journal of Applied Physiology, 115*(6), 1339–1349.
- Ramírez, Y. W., & Nembhard, D. A. (2004). Measuring knowledge worker productivity: A taxonomy. *Journal of Intellectual Capital, 5*(4), 602–628.
- R. Team (2015). RStudio: integrated development for R. RStudio, Inc., Boston, MA. Retrieved from <http://www.rstudio.com>
- R. Team (2018). R: A language and environment for statistical computing. Retrieved from <https://www.r-project.org/>
- Rüdiger, K., & McVerry, A. (2007). *Exploiting Europe's knowledge potential: 'Good work' or 'could do better'. Knowledge work and knowledge workers in Europe. A report prepared for the Knowledge Economy Programme.* London: The Work Foundation.
- Ryan, R. M. (2019, May). *SDT: An incomplete overview.* Plenary talk presented at the 7th International Self-Determination Theory 2019 Conference, Amsterdam, Netherlands.
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78.
- Ryan, R. M., & Deci, E. L. (2002). Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 3–33). Rochester, NY: University of Rochester Press.
- Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness.* New York, NY: Guilford Press.
- Salmela-Aro, K. (2017). Dark and bright sides of thriving – school burnout and engagement in the Finnish context. *European Journal of Developmental Psychology, 14*(3), 337–349.
- Salmela-Aro, K., Rantanen, J., Hyvönen, K., Tilleman, K., & Feldt, T. (2011). Bergen Burnout Inventory: Reliability and validity among Finnish and Estonian managers. *International Archives of Occupational and Environmental Health, 84*(6), 635–645.
- Salmela-Aro, K., & Read, S. (2017). Study engagement and burnout profiles among Finnish higher education students. *Burnout Research, 7*, 21–28.
- Salo, E., Salmela, V., Salmi, J., Numminen, J., & Alho, K. (2017). Brain activity associated with selective attention, divided attention and distraction. *Brain Research, 1664*, 25–36.
- Sandström, N., Sjöblom, K., Mälkki, K., & Lonka, K. (2013). The role of physical, social and mental space in chemistry students' learning. *The European Journal of Social & Behavioural Sciences, 6*(3), 1134–1139.
- Satorra, A., & Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. *Psychometrika, 66*(4), 507–514.
- Scardamalia, M., & Bereiter, C. (2014). Knowledge building and knowledge creation: Theory, pedagogy, and technology. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 397–417). Cambridge, UK: Cambridge University Press.
- Schaufeli, W. B., & Bakker, A. B. (2010). Defining and measuring work engagement: Bringing clarity to the concept. In A. B. Bakker, & M. P. Leiter (Eds.), *Work engagement: A handbook of essential theory and research* (pp. 10–24). East Sussex: Psychology Press.

- Schaufeli, W. B., Bakker, A. B., & Salanova, M. (2006). The measurement of work engagement with a short questionnaire. A cross-national study. *Educational and Psychological Measurement*, 66, 701–716.
- Scholey, A. B., Harper, S., & Kennedy, D. O. (2001). Cognitive demand and blood glucose. *Physiology & Behavior*, 73(4), 585–592.
- Schreier, M., 2012. *Qualitative content analysis in practice*. London, UK: Sage.
- Scott, D. & Usher, R. (1999). *Researching education: Data, methods and theory in educational enquiry*. London, UK: Continuum.
- Seppälä, P., Mauno, S., Feldt, T., Hakanen, J., Kinnunen, U., Tolvanen, A., & Schaufeli, W. (2009). The construct validity of the Utrecht Work Engagement Scale: Multisample and longitudinal evidence. *Journal of Happiness Studies*, 10(4), 459.
- Sipilä, A., Starck, S., & Wegmuller, M. (Eds.), (2017). *3TILAA-muutosagenttivalmennus – Kohti innostavaa työpaikkaa* [3SPACES-transformation agent training program – Towards inspiring workplaces]. Helsinki: Haaga-Helia University of Applied Sciences. Retrieved from <https://www.theseus.fi/handle/10024/144273>
- Sjöblom, K., Hietajärvi, L., & Salmela-Aro, K. (in press). Measuring broad self-regulatory skills in multi-locational knowledge work. *InPractice - The EAWOP Practitioners E-journal*.
- Sjöblom, K., Hietajärvi, L., & Salmela-Aro, K. (2020). Measuring broad self-regulatory skills in multi-locational knowledge work (additional material at open science framework platform: <https://osf.io/v6r5e/>). <https://doi.org/10.17605/OSF.IO/V6R5E>.
- Sjöblom, K., Lammassaari, H., Hietajärvi, L., Mälkki, K., & Lonka, K. (2019) Training in 21st century working life skills: How to support productivity and well-being in multi-locational knowledge work. *Creative Education*, 10, 2283–2309.
- Sjöblom K., Lammassaari H., Huovinen S., & Lonka, K. (2016, November). *3SPACES – Towards inspiring workplaces. Enhancing well-being and co-creating purposeful work practices through mental, physical and virtual modalities*. Paper presented at Nordic Working Life Conference 2016, Tampere, Finland.
- Sjöblom, K., Mälkki, K., Sandström, N., & Lonka, K. (2016). Does physical environment contribute to basic psychological needs? A self-determination theory perspective on learning in the chemistry laboratory. *Frontline Learning Research*, 4(1), 17–39.
- Sparks, K., Faragher, B., & Cooper, C. L. (2001). Well-being and occupational health in the 21st century workplace. *Journal of Occupational and Organizational Psychology*, 74(4), 489–509.
- Smallwood, J., McSpadden, M., & Schooler, J. W. (2008). When attention matters: The curious incident of the wandering mind. *Memory & Cognition*, 36(6), 1144–1150.
- Starck, S., Sjöblom, K., Sipilä, A., Lammassaari, H., Åberg, M., & Lehtinen-Toivola, A. (2017). *3TILAA – muutosagenttivalmennus* [3SPACES – transformation agent training program]. Audiovisual material: video training program. Helsinki: Haaga-Helia yritysysteistyö. Retrieved from https://www.youtube.com/watch?v=TXrkClXkwGk&list=PLYjNcJ1jQZybv7_-TPK02Ca-WSGDgHL2L
- Stenius, M. (2016). *Why share? Motivational Predictors of Individual Knowledge Sharing in Expert Work*. Helsinki: University of Helsinki.
- Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review*, 3(2), 130–154.
- Upadyaya, K., & Salmela-Aro, K. (2013). Development of school engagement in association with academic success and well-being in varying social contexts: A review of empirical research. *European Psychologist*, 18, 136–145.

- Vapaavuori, J., Lindroos, P., & Hjelt, M. (2013). *Valtioneuvoston tulevaisuusselonteko: kestäväällä kasvulla hyvinvointia* [Government report on the future – Well-being from sustainable growth]. Valtioneuvoston kanslian julkaisusarja 18/2013. Helsinki: Edita Prima Oy. Retrieved from http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/79547/J1813_Valtioneuvoston%20tulevaisuusselonteko.pdf?sequence=1&isAllowed=y
- Varao-Sousa, T. L., Smilek, D., & Kingstone, A. (2018). In the lab and in the wild: How distraction and mind wandering affect attention and memory. *Cognitive Research: Principles and Implications*, 3(1), 42.
- Vartiainen, M. (2014). Hindrances and enablers of fluent actions in knowledge work. In P. Sachse & E. Ulich (Eds.), *Psychologie Menschlichen Handelns: Wissen Und Denken–Wollen Und Tun* (pp. 95–111). Lengerich: Pabst Science Publishers.
- Vartiainen, M., & Hyrkkänen, U. (2010). Changing requirements and mental workload factors in mobile multi-locational work. *New Technology, Work and Employment*, 25(2), 117–135.
- Verburg, R. M., Bosch-Sijtsema, P., & Vartiainen, M. (2013). Getting it done: Critical success factors for project managers in virtual work settings. *International Journal of Project Management*, 31(1), 68–79.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Williams, M. (2000). Interpretivism and generalisation. *Sociology*, 34, 209–224.
- Williams, F. (2017). *The nature fix: Why nature makes us happier, healthier, and more creative*. New York, NY: W. W. Norton & Company.
- Wood, C., & Magnello, M. E. (1992). Diurnal changes in perceptions of energy and mood. *Journal of the Royal Society of Medicine*, 85(4), 191.
- Wrzesniewski, A., & Dutton, J. E. (2001). Crafting a job: Revisioning employees as active crafters of their work. *Academy of Management Review*, 26, 179–201.
- Zacher, H., Brailsford, H. A., & Parker, S. L. (2014). Micro-breaks matter: A diary study on the effects of energy management strategies on occupational well-being. *Journal of Vocational Behavior*, 85(3), 287–297.
- Zijlstra, F. R., & Sonnentag, S. (2006). After work is done: Psychological perspectives on recovery from work. *European Journal of Work and Organizational Psychology*, 15(2), 129–138.

APPENDIX

Appendix 1. Self-regulatory skills in multi-locational knowledge work questionnaire.

SELF-REGULATORY SKILLS IN MULTI-LOCATIONAL KNOWLEDGE WORK QUESTIONNAIRE

Scale: 1=not at all true to 5= completely true.

Instructions: Please think of your everyday work routines and assess the extent to which the following statements are true.

1. I plan and schedule my primary weekly tasks. (B)
2. I schedule my tasks according to my typical flow of vigor during the day (for example: work on tasks requiring concentration early in the day). (B)
3. I pay attention to things that maintain healthy vigor for work (for example: starting the day with a good personal routine, utilizing beneficial work strategies, refreshing myself with proper breaks). (R)
4. I pay attention to physical well-being at work (for example: ergonomics, exercise, breaks, nutrition). (R)
5. I aim to minimize unnecessary transitions during the working day. (B)
6. I deliberately restrict factors that distract my attention from the main task at hand (for example: interruptions originating from the work environment, messages from digital devices). (B)
7. I choose an environment that supports my work (for example: a calm environment for focused work, more freely defined surroundings for brainstorming or collaborative work). (B)
8. I aim to be around people who support my work (for example: inspiring or encouraging colleagues or those who can support me in content-related issues). (C-E)
9. I pay attention to successes and the things that I have accomplished at work. (C-E)
10. I find that I am able to deal with challenging feelings and experiences at work. (C-E)
11. I think about the purpose of my work and aim to work in a way that is meaningful to me. (C-E)

12. I develop my work practices. (C-E)
13. In my work community, we discuss work practices and aim to find effective ways to organize work. (C-E)
14. I pay attention to how I approach my work (for example: set reasonable expectations of the quality of my work). (C-E)
15. I make sure that I take sufficient breaks during the working day. (R)
16. I pay attention to sufficient rest in my everyday life. (R)
17. I spend time in restorative environments, such as nature or my own favorite places. (R)

Appendix 2. Pearson correlation coefficients between the items of the Self-regulatory skills in multi-locational knowledge work questionnaire scale.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 q1																	
2 q2	.31																
3 q5	.24	.15															
4 q6	.29	.36	.37														
5 q7	.27	.27	.38	.40													
6 q8	.31	.10	.26	.19	.40												
7 q9	.31	.22	.11	.10	.22	.36											
8 q10	.15	.10	.16	.20	.17	.30	.38										
9 q11	.27	.19	.27	.26	.30	.40	.49	.40									
10 q12	.25	.18	.28	.28	.27	.32	.38	.32	.52								
11 q13	.10	.09	.04	.10	.20	.35	.29	.30	.32	.39							
12 q14	.26	.15	.14	.18	.20	.22	.34	.35	.49	.36	.33						
13 q3	.31	.41	.22	.30	.24	.28	.32	.39	.33	.26	.22	.29					
14 q4	.28	.29	.18	.24	.18	.30	.30	.23	.35	.25	.15	.25	.63				
15 q15	.05	.15	.10	.13	.09	.07	.17	.15	.10	.09	.12	.23	.32	.42			
16 q16	.18	.11	.21	.20	.15	.19	.24	.28	.25	.21	.11	.22	.43	.45	.27		
17 q17	.15	.18	.17	.29	.25	.27	.28	.27	.27	.31	.24	.27	.39	.42	.27	.49	

