Tampere University

TORE STÅHL

Exploring Connections Between Epistemic Beliefs, Internet Reliance and ICT Practices

A study among first-year university students

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ACADEMIC DISSERTATION
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DEDICATION

I wish to dedicate this work to my parents, my grandparents and to those of their age mates who have struggled to make Finland a free, democratic country with freedom of speech, and where all citizens, young and old, regardless of socioeconomic status, have the opportunity to education at all levels.

ACKNOWLEDGEMENTS

In 2010, as I entered the journey to produce this thesis, there was much talk about the so-called net generation. The members of this generation were assumed to master the use of ICT virtuously, and they were also assumed to learn differently compared to earlier generations. I felt suspicious towards the generalisations, and curious about knowing more about what the net generation phenomenon was about, and what it was not. I could hardly imagine that the journey would turn out to be so long. Still, I am pleased to note that, although many years have passed, the topic has not become outdated. On the contrary, new technologies turning up and changing our social, communication and epistemic practices have made the topic even more current but also more complicated.

I wish to express my gratitude to my many supervisors throughout the journey. I wish to thank Professor Juha Suoranta for his support in the initial phase, and Associate Professor (Docent) Tere Vadén for his support during the production of the first article. I am most grateful for the support from my supervisors Professor Emerita Marita Mäkinen and Professor Emeritus Eero Sormunen during the production of the second article and for their co-authorship in the production of the third article. Professor Sormunen's insightful comments regarding the integrative chapter have been especially valuable. I also wish to thank Associate Professor (Docent) Vesa Korhonen for jumping in as supervisor on a moving carriage towards the end of the journey. Finally, I wish to thank the pre-examiners of this thesis, Professor Helge I. Strømsø and Professor Emeritus Erno Lehtinen for their valuable and constructive feedback.

I am grateful to have had the opportunity to participate in the Erasmus Intensive Programme in January-February 2011. The guidance by the supervisors and feedback from peer students were valuable in the initial phase of my research process. Parts of this research was funded by Föreningen Konstsamfundet, Koulutusrahasto and Svenska Kulturfonden. My research also enjoyed the status of a project within the MEDA programme (Media and Education in the Digital Age) at Arcada.

Working at a university of applied sciences and conducting research in education was not an established combination in the 2010s. I am, however, grateful to Arcada

university of applied sciences for allowing me to collect data among the first-year students in 2011 and 2012. I also wish to acknowledge my colleague, E-learning Specialist Filip Levälahti, for his support during the data collection procedures, and, of course, all participating students for participating in the surveys.

I owe a great deal of thanks to many colleagues for both formal and informal engagement, and I would like to especially mention the following. My superior at the time, Vice Rector Tom Lind, encouraged me to start the dissertation journey. Principal Lecturer Emeritus Peter Mildén offered me invaluable support in methodological issues, and after his retirement I appreciate that I was able to continue the methodological discussions with Project Researcher Minna Stenius. Principal Lecturer Emerita Ellinor Silius-Ahonen and Dean Carina Kiukas were always available for discussions about pedagogical topics. Senior Lecturer Nigel Kimberley provided me linguistic guidance during the production of the articles and the integrative chapter. I am grateful for the opportunity to focus on the final article part-time, which was enabled by Rector Mona Forsskåhl. Finally, I wish to thank Principal Lecturer, Docent Matteo Stocchetti for the innumerable discussions around and beyond my thesis work, contributing to keeping up the spirit.

Last but not least, I wish to thank my family, simply for being my raison d'etre.

Kauniainen on January 15th, 2024

Tore Ståhl

ABSTRACT

This dissertation explores the relation between frequent use of internet-based resources, reliance on internet-based resources, and epistemic beliefs. The topic was inspired by everyday observations, indicating that the increasing use of information and communication technologies was changing various practices and, in the context of education, learning practices specifically. The starting point of the dissertation coincided with the contemporary debate around the existence of so-called digital natives. A suspicion arose that the frequent use of internet-based resources may affect changes in students' epistemic beliefs.

The aim of the dissertation is to shed some light on the phenomenon that was initially labelled as the googling approach. Was the googling approach an expression of an underlying reliance on internet-based information, and was the googling approach also an expression of a changed view of knowledge and knowing, that is, changed epistemic beliefs?

The dissertation is, in its entirety, built on survey data collected among first-year students (N=916) representing 15 degree programmes at a university of applied sciences. To respond to the research questions, the data were analysed using statistical methods such as mean comparison, cluster analysis, exploratory and confirmatory factor analysis, and correlation analysis.

This dissertation comprises three sub-studies, with an integrative chapter providing an overview of the background, the methodology, the results, and concludes with a critical discussion of the studies and their results.

Based on the results showing that both ICT practices and ICT skills vary to a large degree, Study I refutes earlier assumptions associated with the debate regarding digital natives versus immigrants. Based on ICT practices, five ICT user clusters were identified and, out of these, only two clusters resembled digital natives in terms of both ICT practices and performance-based tests for measuring ICT skills.

In Study II, a constructivist approach to learning, internet reliance and learning by dialogue were introduced as three new dimensions of epistemic beliefs. Among these, the dimension of internet reliance, expressed a belief in the usefulness and trustworthiness of internet-based information.

The analyses in Study III revealed a positive correlation between three dimensions of epistemic beliefs and internet reliance. These results indicate that internet reliance may go hand in hand with naïve epistemic beliefs, that is, views that consider knowledge as certain, absolute, and unchanging (certainty of knowledge), consisting of unambiguous, isolated bits (structure of knowledge), and basically being handed down by authority (omniscient authority). Considering the overall aim of the dissertation, the positive correlation between internet reliance and the dimension of omniscient authority is of specific importance, since both these dimensions may offer tools for engaging critically with the concept of algorithmic authority.

As a theoretical implication, the dissertation questions the dimensional construct that has been applied so far when measuring epistemic beliefs and it further highlights the importance of including the dimension of justification for knowing. From this theoretical implication follows the methodological implication of framing the items in questionnaire-based measurement into a context that is relevant to the respondent. Contextual framing makes it easier for the respondents to relate to the statements, thereby contributing to more accurate measurement. As a practical implication, the dissertation introduces the concept of epistemic alignment as a principle of learning activities, where topics are presented and learned on an appropriate epistemic level.

Conceptually, the dissertation is located at the crossroads of several disciplines and research areas such as humans and information technology, ICT and media practices, epistemology (on an individual level), educational sciences, and information sciences. The finding that a higher level of internet reliance may go hand in hand with naïve views of knowledge highlights the importance of information literacy in the current world of ubiquitous information from sources that are often unknown or unverified. The correlation between internet reliance and omniscient authority invites caution in the debate about trust in non-human (algorithmic) authorities and is of special interest especially considering the increasing use of algorithmically generated content. An important area for future research would be to explore the extent to which – and on what grounds – users are able to identify the difference between human statements (testimonies) versus algorithmically generated content.

TIIVISTELMÄ

Tässä väitöstutkimuksessa haetaan mahdollisia yhteyksiä internet-pohjaisten resurssien toistuvan käytön, näihin kohdistuvan luottamuksen ja episteemisten uskomusten välillä. Väitöstyö sai alkunsa jokapäiväisistä havainnoista, jotka viittasivat siihen, että tieto- ja viestintäteknologian käyttöönotto oli muuttamassa erilaisia käytäntöjä ja koulutuksen yhteydessä erityisesti oppimisen käytäntöjä. Väitöskirjan alkutaival osui samaan aikaan kuin vilkas keskustelu niin sanotuista diginatiiveista. Heräsi myös epäily, että internet-pohjaisten resurssien runsas käyttö saattaa heijastua muutoksina opiskelijoiden episteemisissä uskomuksissa.

Väitöskirjan päätavoite on valaista ilmiötä, jota tutkimuksen alussa kutsuttiin termillä googlaava lähestymistapa [googling approach]. Ilmentääkö googlaaminen taustalla olevaa luottamusta internet-pohjaiseen tietoon, ja ilmentääkö googlaaminen myös muuttunutta käsitystä tiedosta ja tietämisestä, toisin sanoen muuttuneita episteemisiä uskomuksia?

Väitöskirja rakentuu kokonaisuudessaan kyselyaineistolle, joka kerättiin erään ammattikorkeakoulun ensimmäisen vuoden opiskelijoiden keskuudessa (N=916). Opiskelijat edustivat viittätoista eri koulutusohjelmaa. Tutkimuskysymyksiin haettiin vastauksia analysoimalla aineistoa tilastollisin menetelmin, kuten keskiarvojen vertailulla, klusterianalyysillä, eksploratorisella ja konfirmatorisella faktorianalyysillä sekä korrelaatioanalyysillä.

Väitöskirja koostuu kolmesta osatutkimuksesta ja yhteenveto-osasta, joka antaa yleiskatsauksen tutkimusten taustasta, käytetyistä tutkimusmenetelmistä, tutkimusten tuloksista, ja päättyen kriittiseen keskusteluun koskien tutkimuksia ja niiden tuloksia.

Ensimmäisen osatutkimuksen tulokset osoittivat, että sekä TVT-käytännöt että TVT-taidot vaihtelevat suuresti, ja kumoavat näin ollen aiemmat oletukset kauttaaltaan internettaitoisesta diginatiivien sukupolvesta. TVT-käytäntöjen perusteella tunnistettiin viisi TVT-käyttäjäklusteria, ja näistä klustereista vain kaksi muistutti diginatiiveja sekä TVT-käytäntöjen että suoritusperusteisten, TVT-taitoja mittaavien testien osalta.

Toisessa osatutkimuksessa episteemisten uskomusten ulottuvuuksien joukkoa laajennettiin kolmella uudella ulottuvuudella: konstruktivistinen lähestymistapa oppimiseen, internetluottamus ja dialogiperustainen oppiminen [constructivist

approach to learning, internet reliance, learning by dialogue]. Näistä ulottuvuuksista internet-luottamus ilmaisee uskoa internet-pohjaisen tiedon hyödyllisyyteen ja luotettavuuteen.

Kolmannen osatutkimuksen analyysit paljastivat positiivisia korrelaatioita kolmen episteemisten uskomusten ulottuvuuden ja internet-luottamuksen välillä, mikä viittaa internet-luottamuksen ja naiivien episteemisten uskomusten väliseen yhteyteen. Naiivit episteemiset uskomukset omaava henkilö näkee tiedon varmana, absoluuttisena ja muuttumattomana (certainty of knowledge), koostuvan yksiselitteisistä, yksittäisistä palasista (structure of knowledge), ja että tieto on pohjimmiltaan peräisin joltakin auktoriteetilta (omniscient authority). Väitöskirjan päätavoitteen kannalta erityisesti internet-luottamuksen ja auktoriteettilähtöisyyden välinen positiivinen korrelaatio on tärkeä, koska nämä ulottuvuudet voivat tarjota välineet algoritminen auktoriteetti -käsitteen kriittiseen tarkasteluun.

Teoreettisena implikaationa väitöskirja kyseenalaistaa episteemisten uskomusten mittaamiseen tähän saakka käytettyä ulottuvuuksien rakennetta ja korostaa edelleen tietämisen perustelun (justification for knowing) -ulottuvuuden sisällyttämistä episteemisten uskomusten mittaamiseen. Teoreettisesta implikaatiosta seuraa metodologinen implikaatio, jossa ehdotetaan kyselypohjaisessa mittaamisessa käytettävien väittämien kehystämistä vastaajalle relevanttiin kontekstiin. Kontekstuaalisen kehystämisen ansiosta vastaajien olisi helpompi ottaa kantaa kyselyn väittämiin, mikä osaltaan voisi myötävaikuttaa tarkempaan mittaamiseen. Käytännön implikaationa väitöskirja esittelee käsitteen episteeminen linjakkuus, joka ymmärretään oppimisaktiviteetteja ohjaavana periaatteena, jossa aiheita esitellään ja opitaan tarkoituksenmukaisella episteemisellä tasolla.

Käsitteellisesti väitöskirja sijoittuu useiden tieteenalojen ja tutkimusalojen risteyskenttään, kuten ihminen ja tietotekniikka, TVT- ja mediakäytännöt, epistemologia (yksilötasolla) sekä kasvatus- ja informaatiotieteet. Internet-luottamuksen ja naiivien episteemisten uskomusten yhteyteen liittyvä havainto korostaa informaatiolukutaidon merkitystä nykymaailmassa, jossa tieto on ubiikkia ja usein peräisin tuntemattomista tai vahvistamattomista lähteistä. Internet-luottamuksen ja auktoriteettilähtöisyyden välinen korrelaatio nostaa esiin non-humaaneja (algoritmisia) auktoriteetteja koskevan keskustelun haasteet, ja on erityisen kiinnostava, kun otetaan huomioon algoritmisesti tuotetun sisällön lisääntyvä käyttö. Tärkeä tulevaisuuden tutkimusalue olisi selvittää, missä määrin – ja millä perustein – käyttäjät pystyvät tunnistamaan eron inhimillisten lausuntojen/väittämien ja algoritmisesti tuotetun sisällön välillä.

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ABBREVIATIONS

CFA	Confirmatory Factor Analysis
EBI	Epistemic Beliefs Inventory (Schraw et al., 2002)
EBS	Epistemological Beliefs Survey (Wood & Kardash, 2002)
EFA	Exploratory Factor Analysis
EQ	Epistemic Questionnaire (Schommer, 1990)
FEE	Fragebogen zur Erfassung epistemischer Überzeugungen [Questionnaire for capturing epistemic beliefs] (Moschner et al., 2005)
ICT	Information and Communication Technology
ICTDL	ICT Driving License
ISEQ	Internet Specific Epistemic Questionnaire (Bråten et al., 2005)
JFGI	Just Fucking Google It! (Wiktionary, 2008)
PCA	Principal Component Analysis
SETQ	Students' Experience with Technology Questionnaire (Gray et al., 2009)
UAS	University of Applied Sciences
URL	Uniform Resource Locator, a reference specifying the location of a web resource, https://www.w3.org/TR/url/
WWW	The World Wide Web

ORIGINAL PUBLICATIONS

This doctoral dissertation is based on the following three articles. The articles are referred to in the text by Roman numerals. All the articles have been published and are reprinted under the terms of a Creative Commons Attribution licence.

Publication I Ståhl, T. (2017). How ICT savvy are Digital Natives actually? *Nordic Journal of Digital Literacy*, 12(3), 89-108. https://doi.org/10.18261/ISSN.1891-943X-2017-03-04

Publication II Ståhl, T. (2019). Epistemic Beliefs and Googling. *Frontline Learning Research*, 7(3), 27-63. https://doi.org/10.14786/flr.v7i3.417

Publication III Ståhl, T., Sormunen, E., & Mäkinen, M. (2021). Epistemic beliefs and internet reliance – is algorithmic authority part of the picture? *Information and Learning Sciences*, 122(11/12), 726–748. https://doi.org/10.1108/ILS-01-2021-0004

In all the studies, the author took charge of the general work, conceived the original idea, planned, and performed the data collection, and wrote the manuscripts. In all the studies, the statistical analyses and computations were conducted by the author.

Studies I and II are sole contributions by the author. In study I, Professor Tere Vadén had an advising role, and in study II Professor Sormunen and Professor Mäkinen contributed as advisors.

In Study III, the author drafted the manuscript and performed all the statistical analyses. All the authors discussed and commented on the results and contributed to structuring the final manuscript.

1 INTRODUCTION

The journey to produce this thesis started around 2010, as I was observing first-year university students working on an assignment where they were supposed to search for information on the internet[1] and then use that information for some given purpose. Among other observations, I noticed a student starting the task by entering the term *google* into the search field on the Google start page; that is, the student googled (!) to find Google. I also noticed that, when the task was to use the university library catalogue to find source literature, many students still used Google. The incidents together with numerous similar observations among teacher colleagues, caught my curiosity.

According to a recent review study (Zlatkin-Troitschanskaia et al., 2021), a similar trend towards googling was reported throughout the years 2010-2020 in the reviewed publications. The authors further noted that related research is still lacking or is at least fragmented. Although the trend of increasing googling was generally discussed, the trend itself and especially its potential consequences remained an ill-defined real-world phenomenon. My personal observations among first-year university students raised several concerns that eventually crystallised into the initial research question of the thesis:

> *Does the googling approach go hand in hand with frequent ICT use, and does it express a new way of viewing knowledge, knowing, and learning?*

Existing research and studies did not provide answers to this question, nor did they provide concepts to explore it, but still, there was a body of research that pointed in the same direction as my suspicions, although perhaps in slightly other terms. For example, Horrigan (2007) and Prensky (2001a, 2001b) described the members of the

[1] Although the Internet is basically the technical infrastructure used to access its various services, most people interchangeably use the terms Internet, the net, and the web to denote what is basically the World Wide Web (WWW) and all the services built upon it. Further, the internet is no longer such a new concept that it would require capitalising. Thus, in order not to get caught up in technical details, and for the sake of readability, I use the term internet in the following text as a collective term, denoting both the WWW and various services therein.

young generation as frequent and proficient internet users. On the other hand, for example Kvavik & Caruso (2005) reported that leisure time digital skills did not necessarily transform into the kind of skills required in higher education.

Before moving to the aim and scope of this thesis, I describe the background, the ICT environment and the sociotechnical[2] development that has most probably contributed to the googling approach referred to above.

1.1 The changing sociotechnical environment

When the internet was introduced to the broad public in the mid-1990s, it was necessary to know the URL of the desired web page and enter it into the address field of the browser. As the internet developed into an ocean of information, search engines were developed to help users find what they were looking for. As the amount of information further increased and users realised the usefulness of both information and search engines, it eventually became natural to solve any information need by googling. Looking it up on the net became a self-evident practice, embodied in the expression "Why don't you just google it?" and in the acronym *JFGI!* (Michaelian, 2014; Wiktionary, 2008). With Google becoming the dominant search engine, the verb *googling* became a synonym for information searching on the internet (Andersson, 2017). Sundin et al. (2017) have described this change in information practices as "search-ification of everyday life" and "mundane-ification of search".

1.1.1 The wealth of information

During the first years (approximately 1995 to 2005) of the internet timeline, the number of web sites increased exponentially from 23,500 to almost 65 million (The Real Time Statistics Project, 2022), and by 2022 the number had reached two billion web sites (Chakarov, 2022). As the supply and variety of information increased, people started using the internet as the ad hoc information source (cf. Rainie, 2005) and, for instance, by 2010, 86% of adults in Finland were regular internet users (OSF, 2010).

[2] "Sociotechnical" denotes a combination of people-oriented and technology-oriented practices and projects, where the word "technical" refers to a general technical tendency beyond material technologies, see, e.g., https://www.techopedia.com/definition/33225/sociotechnical/.

Throughout history, education and literacy have relied on what Brandt (1998) refers to as "sponsors of literacy". Educational and religious institutions and the ruling regime have regulated the access to literacy and, applying a broader interpretation of Brandt's concept, to the information that students and citizens can access. With the ubiquitous access to information over the internet, this setting has changed as new "sponsors of information" such as commercial actors and digital technology industries have entered the arena, with some of them having covert and even dubious underlying agendas (Bhatt & MacKenzie, 2019). As the information available to learners is no longer regulated, selected, and prepared to the same extent as before, learners have to engage more in assessing and selecting which information to rely on and to use. Beyond ICT literacies as theoretical, operational and evaluation skills to choose and use ICT and ICT-based services (cf. Gui & Argentin, 2011), citizens also need to develop their information literacies, which can be defined as the skills to search, retrieve, assess and apply information (cf. Sormunen & Poikela, 2008b, p. 10), or the skills to seek, use, and share information in different contexts (cf. Savolainen, 2017, p. 1506).

The wealth of information is not simply a richness of information, but also a field of conflicting forces, in some cases with ideological dimensions. Various internet-based technologies allow sponsors of information to reach out to a global audience and vice versa; that is, users have access to a global ubiquity of information without temporal or geographical constraints. Among the sponsors of information there are, of course, those with noble intentions such as educating the public and providing objective information that illuminates a phenomenon from multiple perspectives. Unfortunately, there are also those who apply a different business logic, where the main aim is to attract viewers and collect clicks by any means, often using such information that attracts attention as a bait (cf. Mößner & Kitcher, 2017). The correctness of the information may even be of secondary importance, and in some cases the aim may actually be to spread disinformation in order to mislead the reader (cf. Fallis, 2015). For ordinary citizens and for learners, there is an increasing challenge in navigating this field of conflicting forces, and in deciding which information to trust and to use when constructing personal knowledge. In addition, there is a risk that the ubiquitous access to information may cause individuals to lose sight of where their own mind ends and where the internet begins (Ward, 2013, p. 88). When the boundaries between external information and personal knowledge become blurred, it may create an illusion of possessing personal understanding (Fisher et al., 2015). The conveniently accessible ubiquity of information is closely related to the topic of search engines.

Biddix et al. (2011), and Alexander & The DRLRL (2012), referring to several studies, addressed the challenge associated with the ubiquity of information whereby convenient access is easily valued higher than the quality of information. In a national context, Kiili (2008) reported about considerable differences in upper secondary students' information seeking skills, and that those with weak skills rarely paid attention to the information publisher or to source evaluation. Also, Hämäläinen et al. (2021) noted considerable differences in upper secondary students' abilities to evaluate online texts. Sormunen & Lehtiö (2011) investigated how upper secondary students used text sources during an authoring task and found a rather extensive use of verbatim or nearly copy-pasted texts. Their results further indicate that some learners do not process information in order to learn, but rather they use it just to (re)produce a text, which the authors address as a problem from a knowledge construction viewpoint. Similarly, Kiili et al. (2012), when investigating upper-secondary pupils, noted considerable differences across groups in the use of collaborative vs. individually oriented online reading[3] patterns. Further, the pupils used, on average, 88% of their working time for locating information and content processing, whereas less than 5% of the time was used for evaluating information. Scheerder et al. (2019) approached the problem qualitatively and noted that the lower and higher educational level groups both experienced the same types of negative outcomes of internet use, but the groups differed in the way they were able to cope with the negative outcomes. In a recent study on data collected during the COVID-19 pandemic, Schultz et al. (2022) addressed the temptation to rely on and to use easily accessible information without assessing it critically.

To summarise, the wealth of information involves three major challenges: 1) in the continuously increasing amount of information, high-quality and distorted information is equally accessible; 2) information can easily be extracted from a source directly into an assignment, without being cognitively processed by the learner, and 3) among the learners, information literacies and practices vary and are partly insufficient.

[3] Online reading (more recently online research) refers to five practices on the internet, namely 1) identifying important questions, 2) locating information, 3) evaluating information critically, 4) synthesising information, and 5) communicating information (Kiili et al., 2012).

1.1.2 On search engines

Search engines are largely trusted, and one of the reasons for users relying on them is certainly that a search for trivial information is very often successful. There is, however, a risk if the user transfers this reliance to searches regarding more tentative information. To exemplify: the fact that the search engine directs the users to the very price list they were looking for, does not mean that the page appearing at the top of the hit list in a search regarding climate change is the most relevant one or even true. It is probably unnecessary to memorise price lists or timetables since they can be looked up, but does this apply for all kinds of information?

Early search engines (before 2000) did not perform actual personalising of search results, but instead, they ranked search results by favouring websites with more links pointing to them (see, e.g., van Couvering, 2008, p. 180; Wall, 2017). Unlike earlier, current search engines provide users with personalised search results (Wall, 2017; Zimmer, 2008, p. 77), which means that the users are, in the worst case, left to construct their knowledge upon biased information. The first advertisement appeared on Global Network Navigator as early as in 1993, but web advertisements as we know them today were introduced by Google in 2000 (Wall, 2017). In 2009, personalised search became default for all Google users (Simpson, 2012). Advertisements and personalisation, and a combination of them, are the key elements of the business logic of today's search engines as they provide users with a free search service and make money by providing space for advertisements. Owing to the personalisation feature, advertisers can reach users with particular profiles aligned with the products or services they offer (Mößner & Kitcher, 2017; Simpson, 2012).

Sundin et al. (2015) point out that the internet is not a neutral medium and address the problematic case of the national Swedish curriculum for compulsory schools, where search engines are seen as neutral infrastructures, which stands in stark contrast to the general curricular aim to foster a critical evaluation of sources. Discrimination is embedded into the search engines' algorithms (Bhatt & MacKenzie, 2019, citing Noble), or as Simpson (2012) frankly notes, the personalisation feature is a direct threat to objectivity. Personalisation means that the information offered to the user is tailored according to what the search engine's algorithm "thinks" will interest the user. Objectivity would, however, require presenting the user also with other views of the topic. Simpson further highlights that search engines increasingly act as surrogate experts with two functions. Firstly, they act as navigational assistants, which basically should not be problematic as long

as they pointed out all possible routes and crossings. Secondly, when guiding the user to supposedly relevant information sources, they disregard routes and crossings that they (algorithmically) deem as irrelevant for the particular user. Thereby, search engines act as "deep experts", that is, as someone that would ordinarily be a human authority whom the user trusts.

1.1.3 Views of knowledge and knowing

With the introduction of the internet and access to its services over browsers in the mid-1990s, various types of information became increasingly available to the broader public[4]. Not having to worry about memorising the information changed the way people accessed and managed information; that is, their information and epistemic practices changed (cf. Biddix et al., 2011; Purcell, Brenner, et al., 2012; Purcell, Rainie, et al., 2012; Säljö, 2010, 2012; Sormunen & Lehtiö, 2011; Sparrow et al., 2011; Sundin et al., 2017).

One of the characteristics of the internet era is the easily and ubiquitously accessible information, and therefore one concern is: do we have to learn and remember at all, since "Why don't you just google it?" Roger Säljö (2010) responds: "Of course, we do have to. But perhaps in this new ecology, what we need to learn and remember, and how we do it, will be different from what we are used to". According to Säljö, the significance of digital technologies is based on the way they affect how society builds up and provides access to social memory. Further, technology changes the communicative environment and thereby our interpretations of what learning and knowing are. (Säljö, 2010)

The anecdote in the introduction actually indicates a changed epistemic and information practice, probably also including a changed view of knowledge, which points towards the concept of epistemology. Epistemology is an area within philosophy that deals with the way a discipline views the nature and structure of knowledge, how knowledge is created, where it resides, and how it is justified (see, e.g., Steup & Neta, 2020). During the past decades, the concept of epistemic beliefs has been in the focus of much research. The concept of epistemic beliefs basically builds upon epistemology albeit on a personal level (Hofer & Pintrich, 1997). Several studies have reported methods for measuring personal epistemic beliefs, as further described in Section 2.2.

[4] Throughout this text, descriptions of general circumstances refer to the context in industrialised, western, mostly Nordic countries.

1.2 Knowledge construction in the university context

Today, everyone with access to the internet can construct their personal knowledge out of building blocks and with tools that were not accessible in the pre-internet era, for better or worse. It is, however, important to bear in mind that the building blocks are mere information which is not the same as knowledge until the person has integrated the information to be part of their personal knowledge. For instance, Huvila (2013) concludes that some users tend to think that merely engaging oneself in searching is almost equal to factual retrieval – "I search, therefore I have knowledge" to make a travesty on Descartes.

Our information practices can relate to so-called everyday life information seeking (ELIS) or work-related information seeking (see Savolainen, 2017, p. 1506). Especially in the context of universities of applied sciences (UAS), providing profession-oriented education, study-related information seeking corresponds to the latter. In the UAS context, in the pre-internet era, textbooks and lectures were the main source of information, but with the internet, online sources are increasingly replacing the more traditional sources. Also in the UAS context, the tendency of "Just looking it up!" may be a result of previous positive experiences in everyday life information seeking.

The tendency of looking it up may indicate that the distinction between ELIS and study/work-related information seeking becomes blurred, and for instance Haider & Sundin (2019, p. 4) note that the common use of search engines is often what blurs the distinction between work and non-work information seeking. Similarly, in his review study, Savolainen (2022) draws the conclusion that work-related and non-work constituents of daily life can be seen as dynamic and mutually influence each other in time and space. In the context of a profession-oriented university of applied sciences, this blur may pose several challenges. Firstly, the internet is a useful resource, but in their future professions the students will also need to possess a baseline body of knowledge readily available to guide their thought and action. Secondly, the goal of profession-oriented education is to help students in developing their professional competencies (including knowledge, skills, and values) and thus, it may turn out problematic if they regard learning as a kind of ad hoc activity where they invest less in prior knowledge and instead, postpone learning to the situation, "just-in-time". Thirdly, in many professions, there are numerous situations where one needs to have the competence and capacity to act immediately, since the (acute) situation does not allow one to look things up. Finally, the internet will perhaps not be accessible in every situation.

1.3 Aim of the thesis

The general research approach guiding this thesis builds on an observed phenomenon that calls for an explanation.

The aim of this thesis is to shed some light on the phenomenon that I, at this stage, choose to call the googling approach. As a result of reflecting upon an initial literature review, I identified three issues, which then provided the structure for the review of existing research:

1) Do the seemingly frequent ICT practices apply to all students, and do they go along with ICT skills?
2) Is the googling approach an expression of an underlying (over-)reliance on internet-based information?
3) Is the googling approach an expression of a changed view of knowledge and knowing, that is, changed epistemic beliefs?

These issues also involved operationalising the assumed internet reliance and exploring if internet reliance is pronounced among specific groups, which, in turn, required the identification of these groups. In more concrete terms, the intention was to use the empirical material to explore how views of knowledge (epistemic beliefs), the googling approach (internet reliance) and the frequency of using various digital services relate to each other.

1.4 Thesis structure

The research methodology of this thesis is guided by the aim to explore possible connections between frequent ICT use, the googling approach which expresses an underlying internet reliance, and young individuals' views of knowledge. Working towards this aim involved a number of concepts, the theoretical bases of which are described more closely in Chapter 2. Chapter 3 presents the actual research questions, followed by the methodological approach in Chapter 4. Chapter 5 presents an overview of the main results of the original studies, followed by the discussion in Chapter 6.

2 EPISTEMIC BELIEFS, THE YOUNG GENERATION AND THE INTERNET

In this chapter, I introduce the concepts I use to work towards the aim of the thesis: 1) *the ICT practices* of users within the young generation and as users of digital technologies; 2) how individuals *view knowledge, knowing and learning*, and 3) the *internet reliance* expressed in an observable googling approach, and how these three concepts can be measured. The first two concepts are presented in the light of previous empirical and theoretical research. The third concept, internet reliance, was taken as an operational notion into the research framework and is elaborated based on empirical descriptions. Basically, no studies were available which explore possible connections between these concepts, which is a research gap that this thesis attempts to fill. The scope of this thesis is located at the crossroads of several disciplines and research areas. This also reflects upon the concepts such that in the following, the introduction of one concept contains components that may also be regarded as part of one of the other concepts.

2.1 ICT practices in a digitalised world

Quite an extensive body of research was available regarding the contemporary ICT and media environment, but mainly in terms of ICT coverage and access, how digital technologies could support learning, and what should be included in digital literacy, which is a tricky issue in a constantly changing environment. ICT practices was also a fairly well covered research area, although not directly applicable due to the rapidly changing ICT and media environment.

2.1.1 The debate

Around the millennial shift, it became apparent that many students related to digital tools and resources differently compared to their parents and teachers (cf. Geraci & Nagy, 2004; Tully, 2003). Already at primary school, pupils seemed to rapidly adopt

the new tools entering both homes and classrooms. The adolescent and young adult segments were most connected, whereas teachers and parents were more reluctant to new technologies (see, e.g., Ala-Mutka, 2011, p. 9; Hargittai & Hinnant, 2008; OSF, 2010). For young adults, using technology was a daily practice as natural as breathing. For instance, when asked about the impact of technology on the future of work, a young interviewee responded: "This [gadget] is only technology for people who weren't raised with it" (Rainie, 2006, citing Rebecca Ryan). The young generation entering universities around the millennial shift was attributed various stereotype labels such as the *net generation* (Tapscott, 1998), *millennials* (Howe & Strauss, 2000; Taylor & Keeter, 2010) and *digital natives*[5] (Prensky, 2001a, 2001b). For a comprehensive overview of the terms used, see for example Jones et al. (2010).

It needs to be acknowledged that younger generations used and embraced technology differently compared to more mature generations. This gap gave rise to a debate, in both public media as well as in scholarly publications within educational sciences, and perhaps even more in publications within computer sciences. A common argument in the debate was that the digital generation possessed characteristics that were a direct outcome of technology use and ICT practices. It cannot be denied that the students born between the mid-1980s and mid-1990s grew up surrounded by increasing ICT resources and eventually also the internet. A majority among them embraced these new technologies fast and to a broad extent, and made the use of internet, ICT, and digital news media part of their everyday practices[6].

Within the debate, the suggested characteristics were generalised and suggested to apply to the whole age cohort. The perhaps strongest and sharpest arguments were presented by Prensky (2001a, 2001b) who stated, for example, that today's students have changed radically, that they think and process information fundamentally differently from their predecessors, that they are used to receiving information fast and prefer random access (like hypertext). Prensky even maintained that students' brains have physically changed due to exposure to digital technology. Anderson & Balsamo (2008, p. 244) engaged in the discussion by describing the generation as just-in-time learners, confident in finding what they need to know and treating their networks as informal Delphi groups.

During this ongoing debate, George Siemens (2005, 2006) presented *connectivism* as a learning theory for the digital age, with similarities to *connective knowledge* described by Stephen Downes (2007). Siemens suggested that knowing, hitherto described as

[5] Hereafter, the term "digital native" is used to denote all three stereotype concepts.

[6] Internet, ICT, and digital news media practices hereafter referred to in the short form ICT practices.

knowing how and *knowing that*, was being supplemented with *knowing where* and *knowing who*, that is, an understanding of in which source or where in one's network to find the knowledge needed (Siemens, 2005, 2006). Siemens did not label the generation but maintained that learners are different, and learning will be different. His statement "The content needs to be findable at the learner's point of need, as compared to learning being provided just-in-case" (Siemens, 2006, p. 37) is an emphasis on immediacy. The statement is also an example of ways of acting and learning which resemble the traits that other authors had attributed to digital natives.

For a time, the public and scientific debate praised the notion of a digital generation without meeting too much resistance. As Best & Kellner (2003) noted, this generation was indeed the first one to grow up surrounded by the internet, multimedia, and new media and consequently, lacking a personal experience of the time before the internet, search engines and mobile phones. In retrospect, this also applies to a large extent to smartphones, which became commonplace in Finland simultaneously around the start of this thesis project. The young generation was also capable of rapidly taking control of the new media environment and the choices it offered to make new services part of their ICT and information practices (cf. Geraci & Nagy, 2004).

Eventually, critics started to raise their voices. Best & Kellner (2003) questioned the assumed stereotypes and suspected that the young generation may be even more heterogeneous than any previous generation. Oblinger & Hawkins (2005) and Kvavik & Caruso (2005) pointed out that students' comfort with technology is not necessarily synonymous with competency, and that the assumption about all students being technologically savvy was not matched by reality. Selwyn (2009) provided a review of recent findings showing that young people's actual use deviated strongly from popular descriptions, partly underpinned by a misplaced technological and biological determinism. Kennedy et al. (2010) concluded that the idea about digital natives and immigrants was nothing more than an oversimplification. Helsper & Eynon (2010) concluded that generation alone does not define digital nativeness, and they further noted significant differences within cohorts of young people regarding skills and use of new technologies. In the Finnish context, for example, Valtonen et al. (2011) reported that Finnish student teachers did not have the expected competencies to apply ICT in their teaching although they belonged to the assumed net generation. Schulmeister (2012), referring to studies in the European context, questioned both the stereotypes and the generalisation, and pointed out that leisure time skills did not translate into the school context.

Bennett et al. (2008) analysed the debate itself and described it as an academic form of moral panic, that is, a situation where an issue achieves such prominence that demands for supporting evidence are ignored, and hasty conclusions are based on the loudest voices. Bennett et al. identified typical characteristics of moral panic such as the debate being spiced with catastrophism and arguments in a dramatic language, proclaiming a profound change, a dramatic shift, and a strong divide, in this case between the new generation and previous generations. (Bennett et al., 2008)

Marshall (2018) explains the phenomenon as a narrative and criticises the common use of digital natives and immigrants for causing a divisive narrative of intergenerational difference without, however, providing an explanation for how these kinds of narratives emerge. Still, the narrative includes treating older people as second-class "immigrants", which does not support these groups in discovering the potential in the new ICT tools and, instead of reducing it, contributes to expanding the digital divide (for a definition, see, e.g., Büchi et al., 2016).

In 2013, Kirschner & van Merriënboer addressed three different urban legends, one of them being that about digital natives, and concluded that none of them were supported by scientific evidence. They further emphasised that the educational sciences need to be theory-driven, and theory development needs to be based on empirical data rather than urban legends and hypes. (Kirschner & van Merriënboer, 2013)

In a more recent retrospective study, Judd (2018) examined the stance of the 17 most cited secondary sources published between 2003 and 2011, that is, sources concerned with or surrounding the three primary sources regarding digital natives (Prensky, 2001a, 2001b), the net generation (Tapscott, 1998), and millennials (Howe & Strauss, 2000). The first critical writings were published as late as 2008 and out of the 17 sources, nine expressed a favourable or consistent view with one of the primary sources, whereas seven were critical and one was neutral. Comparing the citation frequency showed that the nine favourable sources collected 58% of the citations, whereas the seven critical sources collected only 32% of the citations, and the neutral source collected 10% of the citations. (Judd, 2018)

One might expect that the increasing number of critics would have extinguished the debate regarding digital natives and the uniform ICT practices they were assumed to exert. The debate may have decreased, but the concept of digital natives still seems to attract attention. According to Smith et al. (2018), analysing Google trends worldwide, the interest in the search term *digital natives* shows only a slightly decreasing trend over the 10-year period 2008-2018.

As Kirschner & van Merriënboer (2013), Judd (2018) and Marshall (2018) pointed out, the scientific evidence for explaining digital natives was lacking or at least flawed, and consequently, there were no theories or models available that could have provided a framework for observing and investigating the phenomenon of digital natives, an apparent research gap. Still, based on personal observations, anecdotal evidence from teacher colleagues, and, for example, the reports referred to in this section, it was obvious that many students exhibited various combinations of the digital natives' assumed characteristics and ICT practices. Thus, partly considering the prominence of the debate and partly in the absence of an actual theoretical framework, I applied these characteristics, together with ICT practices and ICT skills tests, to frame the exploration of the phenomenon digital natives, as further described in Section 4.2.1.

2.1.2 ICT practices, use patterns and user groups

The debate described in the previous subsection gave rise to various attempts to describe and distinguish the alleged characteristics and ICT user groups. A common denominator for these attempts was that they often explored various activities of using technologies, that is, ICT practices. For instance, the Students' Experience with Technology Questionnaire (Gray et al., 2009) contained, besides background data about study major and socio-economic factors, items regarding access to technology, use frequency and skill level regarding a large number of technologies and services, and the respondent's rating about how useful ICT would be in supporting university studies. In many of the studies, ICT practices were measured in terms of frequency and purpose of use, and data were utilised to form use patterns, which were in turn used to distinguish various user groups (see, e.g., Jones & Hosein, 2010; Kennedy et al., 2010; Thompson, 2013; van den Beemt et al., 2011).

Jones & Hosein (2010) collected longitudinal data regarding technology use in 2008-2009 among first-year students across five British universities and identified what they called technology orientations: web interactive, work-oriented, social interactive, technically oriented, and game-oriented. Based on these technology orientations they identified different user clusters, which varied somewhat depending on the sample.

Kennedy et al. (2010) explored technology use among first-year students born after 1980 across three Australian universities. From the data collected in 2006, they identified seven technology-based activities: standard mobile use, advanced mobile

use, media sharing, creating and using media, gaming, standard web use, and web 2.0 publishing. Based on these technology-based activities they further identified four clusters that they labelled power users, ordinary users, irregular users, and basic users.

Van den Beemt et al. (2011) collected data in 2008-2009 regarding the use of interactive media applications among Dutch students in educational levels ranging from primary to higher professional education. They identified four use patterns for interactive media activities which they labelled interchanging, interacting, performing, and authoring. Based on these use patterns, they further identified four user clusters labelled traditionalist, gamer, networker, and producer.

The ICT practices and user groups identified in the aforementioned studies show some resemblance, but they are not identical, which indicates that the results are dependent on both the sample and the point in time for data collection, that is, the ICT environment. Further, during the past decades, ICT technologies and services that make up the ICT environment have changed rapidly, consequently giving rise to new ICT practices, which, in turn, have raised demands for new technologies and services. Thus, it becomes obvious that ICT practices and the ICT environment are mutually dependent, and the concept of ICT practices is a moving target. Borrowing Savolainen's (2017, p. 1506) definition of information practices, I suggest defining ICT practices, for the purpose of this thesis, as "… the entirety of ways in which people use ICT for various purposes and in different contexts". Acknowledging the constantly changing ICT environment, this definition is not static but requires consideration of the context in which a study is conducted.

Given that the young generation was assumed to be digitally and net savvy, digital literacies (see, e.g., Gui & Argentin, 2011) and digital divide (see, e.g., Büchi et al., 2016; van Deursen & Helsper, 2015; van Deursen & van Dijk, 2019) are topics closely related to digital nativeness. ICT skills were explored in Study I and can be regarded as one aspect of digital literacy, which is a broad and complicated concept (cf. Siddiq et al., 2016). Thus, the topics of digital literacies and digital divide are beyond the scope of this thesis. In this thesis, the ICT and media environments are also not in the focus of the studies since that would require comparing the environments. Instead, the practices are explored at a simpler level, in terms of purposes and frequency of use, and within the contemporary ICT and media environment at the time of data collection.

2.2 Views of knowledge – epistemic beliefs

The starting point of this thesis was a suspicion that the googling approach might express a new way of viewing knowledge, knowing, and learning. For the exploration of views of knowledge and knowing, the concept of *epistemic beliefs* provided a theoretical framework. An extensive body of research around the concept of epistemic beliefs was available, although still with some disagreement about what is to be included in the concept. As described in the following sections, the available models of epistemic beliefs did not, however, acknowledge the relation between beliefs in internet-based information and general epistemic beliefs.

The following subsection provides an overview of the general development within research on epistemic beliefs. The subsequent subsection presents a selection of models that have contributed to how the concept of epistemic beliefs has been managed and operationalised within this thesis.

2.2.1 Definitions of epistemic beliefs and lines of investigation

Interest towards research in personal epistemology or epistemic beliefs can be considered to have started with William G. Perry's (1970) study of college students' ideas regarding *source and certainty of knowledge*. Around the millennial shift, research around epistemic beliefs increased and expanded from Perry's original North American, white male, elite college context to other age groups and geographical and cultural contexts.

The name (epistemological beliefs, personal epistemology, epistemic beliefs) and the definitions of the construct have varied, and Hofer & Pintrich (1997) have addressed the difficulties in reaching a consensus around both naming and defining the construct. Hofer (2002, p. 4) used both the terms personal epistemology and epistemic cognition and described them as including "... [individual] beliefs about the definition of knowledge, how knowledge is constructed, how knowledge is evaluated, where knowledge resides, and how knowing occurs" and further, how the individual uses these beliefs when developing personal conceptions of knowledge and knowing and personal understanding of the world.

As the field of research expands, so does the terminology used. Greene et al. (2016, pp. 1–5) addressed the multi- and interdisciplinarity of this research area, and their use of the term epistemic cognition may be seen as an expansion of the concept. With reference to Sinatra (2016, p. 481) among others, the authors do, however, address the difference between belief and process such that epistemic cognition

should be regarded as the process of thinking that draws on epistemic beliefs and knowledge when reasoning, solving problems, or making decisions. Throughout this thesis, the term *epistemic beliefs* is used to express individuals' (implicit and unconscious) views of knowledge, as distinct from their theories of knowledge or epistemology (cf. Greene et al., 2016, p. 3; Hofer, 2008, p. 5; Kitchener, 2002).

Over the past decades, epistemic beliefs have been conceptualised in mainly two different ways. Earlier researchers represent a developmental-structural tradition and conceive them as broad and developing stage-like (for informative overviews, see, e.g., DeBacker et al., 2008; Schraw, 2013). In the later tradition, Marlene Schommer introduced a line of investigation where an individual's epistemic beliefs are described as a set of dimensions, developing more or less independently (Schommer, 1990, 1993, 1998). Within much of the early literature, epistemic beliefs were regarded as developing over time from a naïve stance towards a sophisticated one (see, e.g., Grossnickle Peterson et al., 2017, pp. 255, 263).

In addition to this latter line of investigation, it has also been suggested that, instead of being general, epistemic beliefs may be associated with, for instance, context, domain, or discipline (see, e.g., Buehl et al., 2002; DeBacker et al., 2008; Hofer, 2000; Muis et al., 2006; Sandoval et al., 2016). There are examples of studies where measurement has been linked to context and domain, although there is some variety in how context and domain have been conceptualised. For instance, Muis, Bendixen, & Haerle (2006) propose distinguishing between three contexts, that is, the socio-cultural, the academic and the instructional contexts. The two latter can hold domain-specific beliefs, whereas the socio-cultural context holds general epistemic beliefs. In a later study, Muis et al. (2016) compared epistemic beliefs by linking them to the domains of mathematics and psychology, and also included everyday knowledge as a kind of general domain. Grossnickle Peterson et al. (2017) regard the internet as a context and suggest task as an element of the context. Bråten et al. (2019) focus on what individuals believe about knowledge in the internet context and how they come to know on the internet. When phrasing the statements included in the Internet-Specific Epistemic Justification Inventory (ISEJ, Bråten et al., 2019), the researchers regarded teacher education as the domain and the internet as the context.

As the examples show, context has been used as an umbrella term that can include various contextual elements, such as domain, discipline, task, or the online setting on the internet. Thus, context can include basically any elements surrounding the situation where an individual exerts epistemic agency. In the following, I therefore

use the term *contextual elements* in connection with the measurement of epistemic beliefs.

2.2.2 Epistemic beliefs as dimensions

Within the line of investigation applied in this thesis, epistemic beliefs are seen as consisting of dimensions, and over the decades, numerous models with various sets of dimensions have been presented. Table 1 provides an overview of those models that have contributed to or influenced the theoretical foundation and instrument construction of the topic within this thesis. A common denominator for these models is that they utilise self-report questionnaires, where the hypothesised dimensions are operationalised as statements, to which responses are collected on anchored 5-, 6- or 10-point disagree–agree scales. The item responses have been subjected to exploratory factor analysis to extract factors corresponding to the expected dimensions of epistemic beliefs[7]. A presentation of the theoretical models inevitably includes frequent references to the instruments and will therefore appear rather technical. The actual instruments are described more thoroughly in Section 4.3.2.

In general, the main reason for conducting research on epistemic beliefs has been the interest to explore how epistemic beliefs affect learning. In her seminal study, Schommer addressed the question "What effects do students' beliefs about the nature of knowledge have on comprehension?" (Schommer, 1990). The first version of Schommer's Epistemological Questionnaire (EQ, Schommer, 1990) is commonly regarded as the starting point for the line of investigation applied in this thesis. Schommer suggested five dimensions, namely *Simple [Structure of] knowledge*, *Certain[-ty of] knowledge*, *Omniscient authority [source of knowledge]*, *Innate ability [to learn]*, and *Quick learning* (Table 1), thus describing views of both knowledge and learning. It is worth noting that Schommer did not perform factor analysis on the 63 original items. Instead, the items were categorised by three experts into 12 theoretically based subsets, for which subscale scores were calculated and in the following exploratory factor analysis, these subscale scores were used as input variables (Schommer, 1990; Schraw et al., 2002, pp. 182, 184; Wood & Kardash, 2002, p. 241). However, in her most cited studies (Schommer, 1990, 1993, 1998), Schommer did not succeed in extracting the omniscient authority dimension. For a long period of time, the five

[7] In the following, I use “dimensions of epistemic beliefs” interchangeably with "epistemic dimension(s)"

original EQ dimensions were the starting point in several successors with varying numbers of items and dimensions, and this was still the case at the starting point of this project in 2010.

Hofer & Pintrich (1997) addressed the importance of how individuals justify what they know and proposed *Justification for knowing* as a new theoretical dimension. Hofer & Pintrich further proposed omitting the learning dimensions and instead, grouping the knowledge-specific dimensions into two general areas, namely 1) the nature of knowledge, containing certainty and simplicity of knowledge, and 2) the nature of knowing, containing omniscient authority (also labelled source of knowledge) and justification for knowing (Table 1).

Hofer & Pintrich (1997) and Sandoval (2009), among others, criticised the Schommer model for including learning dimensions. In his defence for clarity, Sandoval (2009) argues that although learners may conflate their ideas of knowledge with their ideas of learning, the theoretical constructs should distinguish beliefs about knowing from beliefs about learning. Still, according to Sandoval, theories of personal epistemology should also account for how beliefs about knowledge and knowing relate to beliefs about learning.

In developing the Epistemic Beliefs Inventory (EBI), Schraw et al. (2002) had the ambition to construct an instrument where each item would unambiguously express one of the five hypothesised epistemic dimensions. Their interest in the connection to learning shows in their aim to also examine the relationship between epistemic beliefs on the one hand and moral reasoning and problem solving on the other. Their aim was also to extract the dimension of omniscient authority that had failed to extract in Schommer's studies. The EBI contained 28 items out of which only seven were adapted from Schommer's EQ. Schraw et al. collected data by administering both the EQ and the EBI, thus enabling a comparison of these models. As opposed to Schommer, they did not use subsets but used all the original variables as input in factor analysis. The results based on EQ data produced four of the hypothesised dimensions but similarly to Schommer's results, not the omniscient authority dimension. Factoring data based on the EBI did, however, produce a rather clean model with factors that were identical to the five original dimensions, including omniscient authority (Table 1).

Table 1. Overview of dimensions of epistemic beliefs and the number of items representing each dimension as suggested in a selection of studies. Dimension labels have varied depending on model/ instrument.

Author(s)	Schommer, 1990, 1993, 1998	Hofer & Pintrich, 1997	Schraw et al., 2002	Wood & Kardash, 2002	Moschner et al., 2005	Bråten et al., 2005	Study II
Instrument	EQ		EBI	EBS	FEE	ISEQ	
Dimension							
Simple knowledge / Structure of knowledge	19	a)	6	11		x	4
Certainty of knowledge	11	a)	7		7	x	3
Source of knowledge / Omniscient authority	10	b)	4		6	x	3
Innate ability / Learning ability/control	13		6		4		3
Quick learning / Learning speed	10		5	8			
Justification for knowing		b)				4	
Knowledge Construction and Modification				11			
Characteristics of Successful Students				5			
Attainability of Objective Truth				3			
Social dimension of knowledge					5c)		
Value of knowledge					5c)		
Gender-related approaches to knowledge and learning					5c)		
Reflective nature of knowledge / knowing					5c)		
Culture-related aspects of knowledge and learning					6c)		
General Internet Epistemology						14d)	
Connectivist approach to learning							-
Constructivist approach to learning							7
Just-in-time learning							-
Valuing diversity							-
Learning by dialogue							3
Internet reliance							3
Total number of items	63		28	38	43	18	26

Table footnotes

a), b) Hofer & Pintrich did not present an instrument but suggested grouping the knowledge-oriented dimensions into two general areas: a) the nature of knowledge, and b) the nature of knowing.

c) Dimension labels translated from the original German FEE

d) Five of the items were originally written to assess the certainty of knowledge, five items to assess the simplicity of knowledge, and four to assess the source of knowledge, all in the internet context.

Wood & Kardash (2002) criticised the lacking statistical power in interview and other free response formats. They acknowledged that several studies had succeeded in finding differences across educational levels. On the other hand, Wood & Kardash criticised these studies for being less capable of identifying educational interventions that promote learning, or developmental patterns in longitudinal settings. Wood &

Kardash developed the Epistemological Beliefs Survey (EBS) in an attempt to extend Schommer's model. Starting with 80 items, Wood & Kardash performed factor analysis on all the individual variables and ended up with five dimensions, where two EQ dimensions (structure of knowledge and learning speed) replicated somewhat as in Schommer's model. The other dimensions Wood & Kardash labelled *Knowledge construction and modification, Characteristics of successful students* and *Attainability of objective truth* (Table 1). These dimensions did, however, include many of the items that were previously associated with the original dimensions suggested by Schommer.

Moschner et al. (2005), working in a German context, express their learning focus in acknowledging the role of epistemic beliefs for initiating and maintaining learning processes. According to them, a teacher identifying the epistemic beliefs of the learners will be able to make more informed decisions about teaching and learning strategies. A closer look at the new dimensions suggested in their model also indicates a focus on the learning process, a constructivist view of learning and an interest in the practical value of knowledge. Moschner et al. (2005) made an attempt to considerably extend the EQ by developing the 43-item Fragebogen zur Erfassung epistemischer Überzeugungen (Questionnaire for capturing epistemic beliefs, hereafter FEE). In addition to three of the original EQ dimensions (certainty of knowledge, omniscient authority, learning ability), they suggested five new dimensions, namely *Social dimension of knowledge, Value of knowledge, Gender-related approaches to knowledge and learning, Reflective nature of knowledge* and *Culture-related aspects of knowledge and learning* (see Table 1). Factoring the 43 items generated a model containing eight dimensions as expected.

Self-regulation and self-efficacy as aspects of learning, and learning in online settings have been central to the extensive production of Ivar Bråten, Helge Strømsø and their teams (e.g., Bråten & Strømsø, 2005; Strømsø & Bråten, 2010). Bråten et al. developed the Internet Specific Epistemic Questionnaire (ISEQ, Bråten et al., 2005) in an attempt to explore if internet-specific epistemic beliefs might predict any aspects of students' learning in online settings. The model they proposed built on the four dimensions originally suggested by Hofer & Pintrich but applied to an internet context and contained a total of 36 items for assessing the four dimensions. The ISEQ focused exclusively on beliefs in internet-based information, such that each item contained an explicit reference to the internet (e.g., "The truth about almost every issue raised in my classes is located on the internet"). The ISEQ dimensions did not, however, express how the beliefs in internet-based information relate to epistemic beliefs in a general context or in other contexts. As a result of factoring, the ISEQ finally presented only two dimensions based on 18 items, where

the dimension of *General Internet Epistemology* contained a mix of items that previous models associated with certainty, structure, and source of knowledge (Table 1). The ISEQ model is to be regarded as an important step in including the internet context in the exploration of epistemic beliefs.

It can be noted here that also other methods have been used, such as interviews and observations (Andersson, 2017; Gaete et al., 2018; Muis et al., 2016), ethnographic interviews, recorded videography, follow-up interviews and quantitative patterns of digital behaviour (Bhatt & MacKenzie, 2019), think-alouds (Iordanou et al., 2019; Kammerer et al., 2020), and ethnographic methods and focus group interviews (Robinson, 2009, 2011). The aforementioned methods are, of course, capable of providing more in-depth information about how individuals reason regarding knowledge and knowing, but at the same time, they require far more resources than surveys, and are not capable of providing large amounts of structured quantitative data suitable for statistical analyses. For the purposes of this thesis, to acquire a birds-eye view to explore if it was possible to discern something like internet reliance and a possible association with epistemic beliefs, the self-report questionnaire method was regarded as appropriate and sufficient.

To sum up, epistemic beliefs as a construct relies on a broad body of research, although there is some disagreement within the field about what should be included in the concept and whether it can be studied on a general level or connected to some contextual elements. In this thesis I apply the line of investigation where epistemic beliefs are described as a set of dimensions. The dimensions included are partly inspired by previous research, partly developed to meet the demands set by the research questions in this thesis.

2.3 The googling approach and internet reliance

At the time of planning this thesis, the young generation was described in terms such as digital natives, millennials, and the net generation, and in much of the literature (Section 2.1.1), the googling approach was seen as a natural part of the information practices of these individuals. The googling approach can be regarded as an information practice, and thereby as an expression for or indicator of the user's reliance on internet-based information as an underlying attitude, a way of relating to information. How an individual relates to information is closely connected to

individual views of knowledge, perhaps part of the person's epistemic beliefs (Section 2.2), where trust and reliance are key components.

2.3.1 Search as an information and epistemic practice

Searching for information can be seen as a major component in information practices, defined by Savolainen (2017, p. 1506) as "… the entirety of ways in which people seek, use, and share information in different contexts". Our information practices can relate to work-related or non-work-related contexts, the latter one labelled by Savolainen as everyday life information seeking (ELIS) and including areas such as health, consumption, and leisure. Further, ELIS may be about seeking *problem-specific information* such as facts, or seeking *orienting information*, such as monitoring everyday events by using various sources and channels (Savolainen, 2017, p. 1507). It is worth noting that the ELIS model also includes all "traditional" sources and channels such as newspapers, television, radio, and magazines besides personal networks of humans (Savolainen, 2017, p. 1510).

The internet has changed our information practices, according to Savolainen (2017, p. 1512) by complementing more traditional sources and channels. The googling approach does, however, indicate that to a large extent, internet-based sources have not only complemented but almost replaced many of the more traditional sources and channels. One of the reasons may be the wealth of information (see Section 1.1.1) combined with the principle of the least effort, that is, the tendency to look for information where it is most easily accessible (Savolainen, 2017, p. 1512). This change in information practices and the move from traditional sources to internet-based sources also indicates an impact on our epistemic practices, described by Säljö (2012) as "practices that have to do with consulting your own memory, knowing how to make productive use of the external memory systems available and how to find, extract and transform the relevant information". The increase in internet-based information, the development of search engines and what might be called an outsourcing or offloading of memory and information processing seem to feed each other (cf. Sparrow et al., 2011).

For decades now, the teaching and learning practices within most levels of education have emphasised knowing, for instance as in Bloom's taxonomy on different cognitive levels (Bloom et al., 1972; Krathwohl, 2002). Being knowledgeable has been valued, and a knowledgeable person has possessed the kind of *cultural capital* that, in the appropriate *field*, has been regarded as *symbolic capital*

(Bourdieu, 1985, 1986, p. 245). The googling approach, which has increasingly appeared and especially among the young generation from the late 1990s, deviates markedly from the description above: the googling approach suggests that you do not need to know, since you can look it up whenever you need it. Thus, the googling approach as an information practice expresses an *Internet reliance*, that is, an underlying reliance upon the notion that the information one is looking for will be available online, that the information is what one is looking for, and that it is correct. In Bourdieusian terms, the information and epistemic practices of the young generation seems to express other field rules, although playing in the same field as their parent's generation. According to the new rules, being knowledgeable is not the only source of symbolic capital as it used to be but in addition, symbolic capital is also built up of connectedness, networks, and net savviness.

As the internet and internet-based resources were introduced, access to them soon became commonplace in homes, workplaces, and educational institutions. As search engines were introduced, the access to information on the web became convenient, and it seemed increasingly natural to meet any question or inquiry with the light-hearted response "Why don't you just google it!?" This is not surprising since, as Säljö (2010, citing Perriault) notes, technology is never neutral, or as Siemens (2020) expresses it: "we are being shaped by the machine". As we can see with most technologies, be it cars, electricity, or the internet, they tend to change our practices. Sundin et al. (2017) note that the convenient and ubiquitous access to information is changing our information practices, and social media is changing our social (and probably also cultural and information) practices. The tendency of looking it up on the net is probably at least partly a result of previous positive experiences where the search engine has helped users in finding the trivial everyday information they were looking for. Sundin et al. have further described this change in information practices as "search-ification of everyday life" and "mundane-ification of search". Search-ification expresses that an everyday practice of online searching is a self-evident, unquestioned, and frequent activity. Mundane-ification refers to a change in practice where distinctive, identifiable, and goal-oriented searches merge into a constant stream of everyday searches (Sundin et al., 2017).

The study by Robinson (2011), based on focus group interviews with over 300 high school students, indicates a diversity in information practices. Robinson identified four groups of information-seekers (internet-reliant, personal community-reliant, educator-reliant, and multi-channel information-seekers), illustrating that some students turn to the internet, whereas other students turn to human sources (authorities), and some students apply a multi-channel approach.

Given the university context described in the introductory anecdote, there was a concern about how these new information practices might affect students' epistemic practices and university studies. Was there a risk that personal knowledge construction is replaced by fast ad-hoc searches (cf. Heinström, 2005) and copy-pasting (cf. Sormunen & Lehtiö, 2011), and that ease and convenient access will pass source critics in the background?

2.3.2 The googling approach – epistemic agents, trust, and reliance

Search engines are a valuable and indispensable aid in finding the information one is searching for on the internet but the question that needs to be asked is: Can we always rely on the information we find, and if not, when can we rely on the information and to what extent? At the time of planning this thesis, high levels of reliance on internet-based information were common such that, for instance, Purcell, Brenner, et al. (2012) reported that 91% of search engine users felt that they always or most of the time find the information they were seeking, and 73% of users think that most or all the information they find is accurate and trustworthy. They further reported that 66% of search engine users say search engines are a fair and unbiased source of information, younger users being even more reliant than adults. In a contrasting study, the focus was on assessing students' ability to use multiple sources to support an argument, or to recognise bias in online content. Here, teachers rated their students' abilities as very modest or even poor (Purcell, Rainie, et al., 2012). In a recent review, covering studies conducted in the higher education context and published between 2010 and 2020, Zlatkin-Troitschanskaia et al. (2021) noted that the majority of the studies reported students having rather poor search strategies, including, for instance, lacking understanding of the differences between databases and online resources, and using natural language questions in the search box as if posing them to a real person.

Simon (2010) proposes that "trust and knowledge are fundamentally entangled in our epistemic practices". To distinguish between trust and reliance, Simon (with reference to earlier work by Baier) illustrates the difference between trust and reliance with the situation of being let down: in the case of trust, we feel betrayed but in the case of reliance we feel disappointed. A feeling of betrayal can occur especially if we assume the other (epistemic agent) to have acted intentionally. For the purpose of this thesis, I use the terms trust and reliance interchangeably and mostly in the form reliance on internet-based sources or simply internet reliance.

Tollefsen (2009) proposes that when using Wikipedia-based information, we are taking part in testimonies. Applying the more liberal definition of testimony as "tellings in general", we can regard using any internet-based information as taking part in testimonies. Gelfert (2014, p. 15) suggests that, in a broad epistemological sense, we may think of testimony as simply a way of transmitting information. Testimony is, besides perception, inference/reason, introspection, and memory the most important route to knowledge (e.g., Chinn et al., 2011; Gelfert, 2014, p. 55; Simon, 2010; Steup & Neta, 2020). Simon further states that we are generally disposed to credulity, that is, in believing the testimonies of other epistemic agents. But as Simon notes, epistemic agents on the internet do not always produce epistemic content, let alone knowledge.

Traditionally, the epistemic agents have been other people. However, on the internet, the user is dealing with, besides *known human* epistemic agents, also with *unknown human* epistemic agents and with *non-human* agents, for instance, the search engines (or actually the algorithms behind them). Trust mostly builds upon authority and in the case of the internet, the user is often (unknowingly) trusting a new mode of authority, *algorithmic authority*. The concept was first presented by Clay Shirky in 2009 (see, e.g., Simon, 2010; Sundin et al., 2017). Shirky's original definition was later modified by Lustig & Nardi (2015) to read "the trust in algorithms to direct human action and to verify information, in place of trusting or preferring human authority". Thus, algorithmic authority differs from traditional forms of trust, such as personal or institutional trust.

As noted above, Tollefsen (2009) accepts Wikipedia entries as testimonies, as tellings in general, and similarly, Origgi & Ciranna (2017, p. 310) note that many online interactions are about giving information to others and are thus testimonial in nature. The question arises: whose testimonies are they? The same question of course applies to a large part of internet-based information, specifically where the teller/narrator cannot be identified or is unknown to the hearer/reader.

Huvila (2013) collected just over 800 utterances related to search engine use by harvesting them from discussion forums and blogs. When exploring the utterances to find expressions of trust based on cognitive authorities, he identified three types of sources of authority: 1) people, 2) search as an approach, and 3) search as an activity. Huvila found that the majority or 37.6% of the utterances indicated "searching as an activity" as the source of authority. The corresponding numbers for "people" and "search engine use" as sources of authority accounted for 33.4% and 16.4%, respectively. In 12.5% no explicit authority claim could be identified. The search activity itself as an authority was based on the conception that already the

effort of searching implies that the results have to be correct or relevant. The search engines' ranking was also perceived as a trusted authority, expressed in the informants' perceptions that the relevant results are simply to be found among the first ranked results and conversely, that out-dated or irrelevant results have been automatically excluded from the top results. The recent findings by von Hoyer et al. (2022) show some similarities; they identified a so-called false certainty effect, meaning that after an information search activity, individuals felt more confident that their previous knowledge was correct, even when the previous knowledge was actually incorrect.

To sum up, internet reliance has been described in previous research to some extent but not so far operationalised as a measurable construct (regarding operationalisation, see Section 4.3.2 and Study III, Table 3). Further, previous studies have touched upon internet reliance in terms of changes in information practices but so far without elaborating the impact on learning and knowledge construction. For the purpose of this thesis, I regard internet reliance as a reliance upon the notion that the information one is looking for will be available online, but also that the information is what one is looking for and that it is trustworthy.

2.4 Summarising previous research

Working towards the aim of the thesis required the use, including measurement and comparison, of three specific concepts: ICT practices, epistemic beliefs, and internet reliance. Out of these concepts, only the concept of epistemic beliefs had been in focus of profound theoretical consideration and in extensive attempts to operationalise the concept as a measurable construct. ICT practices had been studied mainly from an empirical viewpoint, while internet reliance remained the least studied concept.

The lively debate at the time regarding so-called digital natives did not present a definition that would have served identifying the digital natives and distinguishing them from other user groups. Thus, for the purpose of this thesis, ICT practices were measured and compared in order to describe and identify various groups within the sample.

How individuals relate to knowledge and knowing has been described using the concept of epistemic beliefs as a set of dimensions. Some studies describing epistemic beliefs regarding internet-based information were available, but not

regarding the relation between general epistemic beliefs and internet-based information.

The research question assumed a reliance on internet-based information but at the time of planning the studies within this thesis, the concept of internet reliance had not been defined, nor was there an instrument to measure the level of an individual's internet reliance, which constituted a research gap.

To sum up, out of the concepts that have been used so far, the googling approach and ICT practices can be seen as observable behaviours that can be operationalised. Internet reliance can be seen as an underlying attitude that manifests itself in the googling approach, and internet reliance can be measured for instance by operationalising this attitude in terms of statements. Similarly, ICT practices can be operationalised as measurable ICT activities. Epistemic beliefs can hardly be described as an observable behaviour, but instead, they have been described as consisting of dimensions, which have been operationalised and measured in terms of statements.

2.5 Scope and delimitation of the thesis

At the time of planning this thesis, there were no concepts or theories available to explain the phenomenon of using googling light-heartedly in basically any situation or information need. Only vague and over-generalised descriptions (e.g., Anderson & Balsamo, 2008; Prensky, 2001a, 2001b; Siemens, 2005, 2006) had been presented about the assumed properties of the young generation, which altogether constituted a research gap.

Regarding views of knowledge and knowing, research around the concept of epistemic beliefs had been going on for almost two decades, but the theories and models available were not able to capture how the googling approach is connected to views of knowledge, knowing and learning, which thereby constituted another research gap. Epistemic beliefs and their possible association with the googling approach and frequent ICT use appeared subjectively and empirically obvious, but was there evidence?

Considering the aim of the thesis, it becomes obvious that the scope of this thesis is located at the crossroads of several disciplines and research areas, such as humans and information technology, ICT and media practices, epistemology (on an individual level), educational sciences, and information sciences. In addition, all the

main topics contain various subtopics, which altogether builds up a rather complicated picture:

- ICT practices are connected on the one hand to access to ICT resources, and on the other hand to the skills to use digital tools, also called digital literacy (e.g., Gui & Argentin, 2011). Lacking access and lacking literacy affect each other mutually and may both be at least partial causes of various levels of the so-called digital divide (see, e.g., Büchi et al., 2016; van Deursen & Helsper, 2015; van Deursen & van Dijk, 2019).
- Within the research area of epistemic beliefs, there is a broad body of research focusing on – besides general epistemic beliefs – the connection between epistemic beliefs and self-regulation (e.g., Muis, 2007), culture (e.g., Bråten et al., 2009), contextual elements (e.g., Grossnickle Peterson et al., 2017; Muis et al., 2006, 2016), and on epistemic change (e.g., Kienhues, 2016; Kienhues et al., 2008; Muis & Duffy, 2013).
- The googling approach and internet reliance occur in both the learning context and in the everyday life context. Within the learning context, a closely related area is that of online pedagogy, for which there is an extensive body of research, ranging from early studies about integrating technology with learning (e.g., Jonassen, 1995) to later work around flipping the classroom (e.g., Strayer, 2007) and blended learning (e.g., Vaughan et al., 2013). Within both contexts, information practices is a central concept (e.g., Savolainen, 2017; Sundin et al., 2017), together with information literacy (e.g., Huvila, 2013; Sormunen & Poikela, 2008a; Sundin, 2015).

For the purpose of this thesis, it is necessary to delimit the investigation to a manageable scope and to delimit the number of components in such a way that it is possible to discern the contours emerging from the analyses. Consequently, I abstain from issues regarding digital literacy and information literacy, digital divide, contextual elements regarding epistemic beliefs and their connection to self-regulation and epistemic change, and from issues regarding online pedagogy. First-year students are used as informants but otherwise, I exclude the vast areas of "first-year students", "first-year experience", etc. I deal with ICT practices on a basic "purpose and frequency" level and with epistemic beliefs on a general (decontextualised) level. The topic of internet reliance is initially based on the assumption that the concept of internet reliance can be seen as an epistemic beliefs dimension.

Regarding target group, the scope of this thesis is delimited to exploring the aforementioned issues among students. Basically, the group of interest extends beyond the students mentioned in the introductory anecdote and includes all young individuals belonging to the so-called millennial generation. Comparing the target group with some adult sample was also beyond the scope of this thesis.

3 RESEARCH QUESTIONS

This thesis project was initiated by the personal observation of how young students appeared to rely on internet-based information when relating to knowledge and knowing, which gave rise to the overall aim of this thesis: "Does the googling approach go hand in hand with frequent ICT use, and does it express a new way of viewing knowledge, knowing, and learning?"

To tackle the aim, the thesis was set up in three individual studies, each of them guided by its specific research questions. Study I focuses on students' ICT practices, ICT user groups, and ICT skills. Study II focuses on extending the dimensions of epistemic beliefs so as to capture possible internet-specific aspects of epistemic beliefs. Study III combines parts of the results of the Studies I and II to explore possible associations between epistemic beliefs, internet reliance and ICT practices, as illustrated in Figure 1

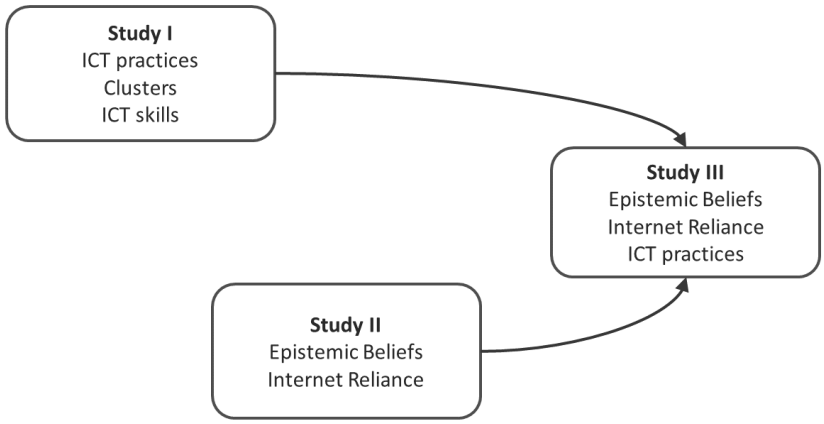

Figure 1. Concepts within the thesis and how they appear in the individual studies.

The specific research questions developed along with increasing knowledge about the research area. Some of the research questions were also adjusted or rephrased

due to new information emerging from the individual studies. It is also worth noting that data collection took place in 2011 and 2012 and consequently, phrasing the initial research questions and planning the data collection was based on research that was available, and in the context and climate of that point in time.

3.1 Study I

The young generation born between the mid-1980s and mid-1990s was assumed "born digital" and assumed to be frequent internet users and computer and net savvy. These assumptions dominated the contemporary debate although, as later shown (e.g., Kirschner & van Merriënboer, 2013; Judd, 2018), the scientific evidence was either lacking or flawed. Study I adopts a sceptical but open stance to the generalised debate and focuses on describing and identifying various types of ICT and media users, partly to explore if it is possible to discern and identify the assumed digital natives. The categorisation was based on the users' ICT practices and use patterns.

Study I was structured around the following questions:

- What groups can be identified based on users' ICT practices?
- What are the actual (performance-based) ICT skills among young people and compared across groups?
- To what extent can groups within the young generation be regarded as digital natives or native-like?

3.2 Study II

The initial research question of this thesis included a concern regarding new ways of viewing knowledge. However, the instruments used so far for measuring epistemic beliefs were unable to capture how individuals relate to internet-based information and/or the internet as a knowledge source. Study II explores how instruments for measuring epistemic beliefs can be extended to capture views of internet-based information and how these views relate to previously described dimensions of epistemic beliefs. This exploration is a journey in uncharted territory, where the suggested epistemic dimensions are partly based on contemporary descriptions of the young generations' information practices (Sections 2.1.1 and 2.3).

Study II focused on the research question:

- How can the set of dimensions of epistemic beliefs be extended so that it also expresses and measures a googling approach and/or a reliance on internet-based information?

3.3 Study III

As illustrated in Figure 1, Study I and Study II served the preparation of Study III. This study connects back to the initial research question of this thesis about the googling approach possibly expressing a new way of viewing knowledge, knowing, and learning. For this study, Study I provided the concept of ICT use patterns including the individual scores expressing these patterns. Study II provided individual scores expressing various dimensions of epistemic beliefs. Study II also provided the concept of internet reliance (expressing the googling approach) including the corresponding individual scores. Deviating from Study II, internet reliance is here not regarded as an epistemic dimension but rather as a separate personal trait.

Utilising 1) the various types of ICT practices identified in Study I, and 2) the dimensions of epistemic beliefs and internet reliance identified in Study II, the research question for Study III reads:

- To what extent are users' epistemic beliefs, their internet reliance and their ICT practices associated?

4 METHODOLOGY

In this section, I present how the initial research question of this thesis has guided the general research approach and research strategies. I describe the research methodology in terms of concept operationalisation and instrument development. Following that, I describe the data collection procedures, sample descriptives, and analysis methods applied in each of the studies. I conclude by describing how the ethical and security considerations have guided the methodology.

4.1 Methodological choices and strategies

The overall aim of the thesis required dealing with several concepts and phenomena, that is, characteristics of the young (digital) generation, the contemporary ICT and media environment, and epistemic beliefs, then comparing them and finally, describing possible associations between them. Exploring possible associations across these concepts was a journey in uncharted territory (also see Section 2.4). Thus, at this stage, the ambition was not to produce results that would be generalisable to a larger population. Rather, the aim was to collect material that was broad enough to allow for conducting reliable statistical analyses, for testing the instruments, and for assessing if the results indicate any of the suggested associations. If such indications did appear, future studies would then be conducted on a larger sample. The choice at this stage was to approach the phenomenon quantitatively in order to acquire an initial bird's-eye view. Since this also included using modified and therefore untested instruments, the aim was expressly explorative, without aspiring to generalisability. To enable statistical analyses, the concepts were operationalised, and quantitative data were collected online using self-report questionnaires.

All three studies build upon the same set of data, although each study deals with different aspects and subsets of the data (for an overview, see Figure 4, p. 59). The data were collected among two cohorts of first-year university students and the results are therefore temporally bound to a specific ICT and media environment. As

Zlatkin-Troitschanskaia et al. (2021) point out, the results are then also bound to learning behaviours of that time.

At the time of planning the data collection, theories explaining the digital natives were not available, and thus also instruments for measuring and identifying digital natives were unavailable (Section 2.1). Instruments for measuring epistemic beliefs were available but not sufficient for the purpose of the current research problems (Section 2.2.2). Thus, a number of preparatory steps were required in the first two studies to define concepts and construct the instruments required in the third study, dealing with the overall aim of the thesis:

Study I – ICT practices

- Describe different ICT use patterns based on ICT practices.
- Based on ICT use patterns, identify different types of ICT users, among them the assumed digital natives and other comparison groups.

Study II – Epistemic beliefs and internet reliance

- Select an epistemic instrument to measure views of knowledge, knowing, and learning.
- Extend the epistemic instrument to capture how individuals relate to internet-based information.

Study III – Combining the concepts

- Explore the relationships between ICT practices, epistemic beliefs, and internet reliance.

4.2 Operationalisation of key concepts

The central concepts in the studies in this thesis include 1) ICT practices, 2) original, hypothesised, and novel dimensions of epistemic beliefs, and 3) internet reliance. The central concepts are operationalised using items included in the self-report surveys.

4.2.1 ICT practices and skills

The characteristics attributed to digital natives were on the one hand about a versatile and frequent use of all kinds of ICT and digital media, and on the other hand about digital natives being ICT savvy.

In Study I, identifying the various types of ICT and media users was approached in an exploratory manner, starting with collecting data that described the students' ICT practices using self-report questionnaires. Exploration of ICT practices followed the earlier suggested definition as "the entirety of ways in which people use ICT in different contexts". The exploration was inspired by various descriptions of the contemporary young generation, and by applying methods from similar previous studies, data were used to create ICT use patterns, which were then used as input in cluster analysis. Cluster analysis was chosen because the clusters that emerge are not affected by preconceived assumptions but are based solely on input data. Thus, cluster analysis allows data to "speak for itself".

Since ICT practices and use patterns are always dependent on the contemporary societal and technological environment, the practices and use patterns presented in this study may be compared across groups within a sample, but most likely, they are not replicable at another point in time or in another sample. Consequently, as for this study, this also applies for the clustering of users, which was based on their ICT practices and use patterns (cf. Section 2.1.2). Identifying the ICT user clusters was a preparation for a comparison of the assumed ICT savviness and a later comparison of epistemic beliefs across clusters.

4.2.2 Epistemic beliefs

Previous studies within the chosen line of research (Section 2.2) explored epistemic beliefs using self-report questionnaires containing statements that were operationalisations of the various dimensions of epistemic beliefs. The statement responses were then subject to exploratory factor analysis, where the extracted factors were expected to express the anticipated dimensions. In order to enable replication, the studies within this thesis applied the same methods with self-report questionnaires, exploratory factor analysis, and internal replication using both exploratory and confirmatory factor analysis. Access to rather large samples also spoke in favour of these methods.

The operationalisation of the hypothesised dimensions of epistemic beliefs was inspired by contemporary descriptions of the young generations' information practices (Sections 2.1.1 and 2.3).

4.2.3 Internet reliance

Instruments for measuring internet reliance were not available at the time of planning Study II. Therefore, the operationalisation of the assumed internet reliance followed the earlier suggested definition as "a reliance upon that the information one is looking for will be available online, and that the information is what one is looking for, and that it is correct". The operationalisation was inspired by contemporary descriptions of how members of the young generation went about searching for information on the internet (Sections 2.1.1 and 2.3). In Study II, these items were assumed to express new dimensions of epistemic beliefs and were therefore part of the exploratory factor analysis. In Study III, internet reliance was not regarded as part of the epistemic beliefs but rather as a personal trait.

4.3 Instrument development

4.3.1 Measuring ICT practices and skills

ICT practices

To explore the ICT practices, I developed the survey *Me, ICT and media*, using the Australian Students' Experience with Technology Questionnaire (SETQ, see Gray et al., 2009; Kennedy et al., 2008) as a starting point. I further modified the SETQ to correspond to the contemporary ICT environment, such as 3G mobile connectivity. The survey Me, ICT and media included altogether 89 items covering the following areas (Appendix 4):

- socio-economic background, technology history, and technology access,
- use of social media (only 2011),
- self-reported use frequency and skills regarding computers, web activities, and mobile phone activities,

- expectations regarding the use of ICT at the university,
- news media practices,
- reading habits.

As in the SETQ, use frequencies and skills were registered parallel (see Figure 2), and use frequencies were registered on a 7-point anchored scale, ranging from 'Once-twice a year' up to 'Several times a day'. Skills were also registered on a 7-point anchored scale but in this case ranging from 'Poor' up to 'Excellent'. Thus, the skills scale corresponded with the Finnish school grades scale that was familiar to the domestic students constituting the majority of respondents.

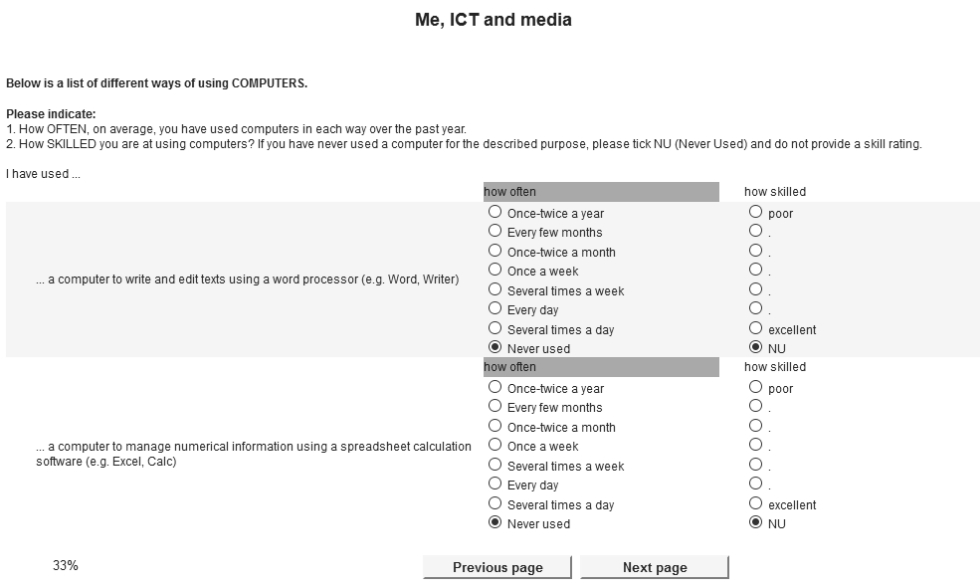

Figure 2. Screenshot illustrating sample items in the survey *Me, ICT and media*.

The ICT Driving License

As mentioned previously, the young generation was commonly assumed to be ICT savvy (see Section 2.1), but one of the problems associated with this issue was that in many studies, ICT skills were self-reported instead of measured using performance-based tests. To remedy this deficiency, the ICT Driving License (hereafter ICTDL) was included as part of this study to enable the exploration of the assumed ICT savviness and to base this exploration expressly on performance-based

tests in an authentic online environment (cf. Aesaert & van Braak, 2015; van Deursen et al., 2012; van Deursen & van Dijk, 2009). The ICTDL was already present as a compulsory part of the basic studies in all study programmes and was thus not part of the actual instrument construction process. The ICTDL level tests contained five modules covering what was considered basic ICT topics at that point in time (cf. the ST²L, Hohlfeld et al., 2010):

1. Basic computer use including file management, software and hardware usage, internet, and email.
2. The ICT services at the university (excluded from analyses).
3. Modifying and presenting data, including basic tools for word processing, spreadsheets, and presentations software.
4. Information seeking, library catalogues and reference databases.
5. Information security and privacy protection.

Module 2 did not reflect the kind of ICT skills expected from students as they entered university studies and was therefore not included in the analyses. The ICTDL was provided as an external service from the University of Helsinki, already available in Swedish and English and therefore did not require translation or content updates. Unfortunately, the original web site of the University of Helsinki ICTDL is no longer available but similar objectives and content are expressed in the current corresponding module called Student's digital skills (University of Helsinki, 2022).

4.3.2 Measuring epistemic beliefs and internet reliance

To explore if the googling approach expresses a new way of viewing knowledge and learning, it was necessary to apply a tool to measure the knowledge view of individuals, so called epistemic beliefs, but also to relate the epistemic beliefs to an assumed reliance on internet-based information.

As mentioned earlier (Section 2.2.2), previous instruments were not able to capture epistemic beliefs in connection with internet-based information, or if they did (e.g., Bråten et al., 2005; Bråten & Strømsø, 2006; Strømsø & Bråten, 2010), the beliefs in internet-based information were not described in relation to the broadly used original dimensions (Section 2.2.1). This can also be regarded as a research gap and a state of construct under-representation where the existing scale items do not provide a complete assessment of the trait to be measured (Finch et al., 2016, p. 97).

Therefore, there was a need to extend previous instruments, and for that purpose I sought inspiration from previously developed instruments (Section 2.2.2, Table 1) as well as from literature describing how the young generation uses internet-based information and learns from it (Sections 2.1.1 and 2.3).

To measure epistemic beliefs, two versions of the instrument were used. The work by Moschner et al. (2005) inspired the 2011 version of the questionnaire but owing to failed replication, most of the FEE-specific dimensions were discarded from the 2012 version of the instrument (Table 1, p. 31).

The revised instrument (Appendix 5) contained 60 items representing, firstly, four of the five original EQ dimensions, namely certainty of knowledge, structure of knowledge, omniscient authority, and learning ability. Secondly, the revised instrument contained six hypothesised epistemic dimensions labelled *Internet reliance, Just-in-time learning, Connectivist approach to learning, Reflective nature of learning, Constructivist approach to learning,* and *Valuing diversity*. Since the students were not assumed to be familiar with the contents of their future study programme, the students were instructed to respond with the past year in mind. Thus, the epistemic items were measured on a general level, without connection to contextual elements, nor did they distinguish if the information was what in the ELIS model (Savolainen, 2017, p. 1507) is denoted as problem-specific vs. orienting information.

At the time of planning this research, I assumed internet reliance, i.e., reliance on internet-based sources, to be a dimension of epistemic beliefs. The ISEQ had been introduced (Bråten et al., 2005) but unfortunately, I had missed their study when searching background literature. In retrospect, the internet reliance items in this thesis still resemble several of the items suggested in the ISEQ, although the ISEQ items focused exclusively on internet-based information (Section 2.2.2) and did not express how they relate to other dimensions of epistemic beliefs. Thus, the five items describing internet reliance (Study III, Table 3) were mainly inspired by literature regarding the so-called digital natives (e.g., Anderson & Balsamo, 2008; Bullen et al., 2011; Prensky, 2001a; Siemens, 2005, 2006) and claims about their characteristics and their alleged preferences for internet sources instead of printed sources (cf. Head & Eisenberg, 2010; Purcell, Rainie, et al., 2012). The items were phrased to reflect a reliance on always being able to find any information you need on the internet, and that the information you find is reliable.

The dimension of just-in-time learning was inspired by the speculative scenario of future learners, where Anderson & Balsamo (2008, p. 244) described the young generation as "…knowing and being confident where to find information once they need it". Similarly, Bullen et al. (2011) described the need for immediacy as a net

generation feature, and Siemens (2006, p. 31) suggested deciding what to memorise and choosing what to learn as characteristics in a connectivist learning approach.

The dimension of connectivist approach to learning was generated from the descriptions of connectivism provided by George Siemens (2005, 2006, pp. 31, 91) and Stephen Downes (2007) but also by Anderson & Balsamo (2008, p. 244) suggesting that "They treat their affiliation networks as informal Delphi groups".

The dimension of Reflective nature of learning was deduced from a dimension suggested in the FEE instrument by Moschner et al. (2005), although they had suggested the format *Reflective nature of knowledge*. The items associated with this dimension were rephrased to describe the reflective nature of learning. This dimension deals with the learning aspect and was intended to express a reflective stance, as opposed to a static and authoritarian stance towards new knowledge.

The dimension of constructivist approach to learning had yet not been suggested in any of the previous instruments, although the dimension of knowledge construction and modification presented by Wood & Kardash (2002, p. 250) and the dimension reflective nature of knowledge (Moschner et al., 2005) may suggest something in this direction. The writings of Siemens (2006, pp. 6, 20, 31) have also inspired the phrasing of some of the items proposed to describe a constructivist approach.

The dimension of valuing diversity was suggested by Siemens (2006, pp. 16, 31, 56, 117) as a central trait of connectivism. Valuing diversity requires interaction (Downes, 2007, p. 78) and also involves exposing oneself to different and divergent opinions, all contributing to the individual learning process. This trait, requiring "… the widest possible spectrum of points of view…" (cf. Downes, 2007, p. 99; Siemens, 2006, p. 16), can be regarded as an expression for a general scholarly approach.

Finally, it is important to acknowledge that the dimension of justification for knowing is definitely to be regarded as one of the established dimensions of epistemic beliefs. The development of the instrument for this thesis was strongly influenced by the FEE (Moschner et al., 2005), where justification for knowing was not included. Omitting justification for knowing from the instrument may seem an oversight, but the decision was influenced by the fact that the other instruments available at that time (see Table 1, p. 31) also omitted justification for knowing.

4.3.3 Cultural adaptation

The sampling frame (Section 4.5) consisted of first-year students at a bilingual university of applied sciences, which required, on the one hand, data collection instruments to be provided in both Swedish and English and on the other hand, cultural adaptation.

The SETQ instrument (Section 4.3.1) was already available in English and thus, in addition to content updates, it needed to be translated into Swedish and culturally adapted. The epistemic beliefs instrument was considerably extended (Section 4.3.2). Large parts of it were available in English but it required translating, and in addition, the whole instrument required cultural adaptation.

Language and (youth) culture are closely connected and therefore, perhaps the most important aspect of the cultural adaptation of the questionnaires was the simultaneous translation and (re)phrasing of the items into first person present tense, as suggested earlier by, for example, Kitchener (2002) and Schommer-Aikins (2004). The primary aim was that the phrasing should clearly express that the researcher was interested in knowing what each student thinks, not what the students think people in general think, or what they assume is socially desirable to think about a topic. Thus, for example, the passive item phrasing "Answers from a teacher have to be accepted as true" was rephrased as "I have to accept the answers from a teacher as true". Some items were improved by simplifying the sentence structure and/or by removing a subordinate clause. Throughout the process of translation and rephrasing, I strictly observed maintaining the true meaning of each item while at the same time avoiding such rephrasing that might hamper replication.

The questionnaires were tested during read-aloud sessions (cf. think-aloud, see Wilson & Gochyyev, 2013, p. 12) with both domestic and English-speaking international students, and a pilot test with a small group of students. During the read-aloud sessions, the students were asked to read the items aloud and to comment on their comprehensibility. Also, if the student faltered while reading, I interpreted it as a possible comprehensibility problem and intervened by asking if the item was clear and easy to understand. During the read-aloud sessions, the students supported the use of direct and active wording. Both the read-aloud sessions and the pilot test provided valuable information regarding comprehensibility, and they contributed to improving both the item wording and questionnaire functionality.

4.4 Data collection

To enable the analyses required, three data sets were collected in the following order:

1. Me, ICT and media – Survey data describing, among other things, the students' self-reported ICT practices and skills, access to technology and technology history, and media practices.
2. ICT Driving License level tests – Data generated from the compulsory ICT Driving License (ICTDL) level tests, describing the students' performance-based ICT skills within four areas.
3. Me and my knowledge – Survey data describing the students' epistemic beliefs.

In the beginning, the study was part of a development project at the university and thus, besides using background data from the student registry, it was possible to organise data collection in connection with the time slots scheduled for the compulsory ICTDL level tests. In order to get an "authentic snapshot" of the students' mind-sets before they were exposed to the university's pedagogical and epistemic influences, the supervised sessions were scheduled during the very first week of the academic year.

4.4.1 Survey distribution

The surveys *Me, ICT and media* and *Me and my knowledge* were set up as online questionnaires and distributed by two personal invitations to each student's university email address. The invitations (Appendix 1) contained a unique link to each respondent's personal questionnaire. Access to the ICTDL level tests was provided over the university's online learning environment within a course to which all new students were automatically enrolled. Thus, accessing both the level tests and the email invitations required logging in using the personal credentials provided by the university.

In addition to the collected data, the university's student registry provided background and demographic data describing each respondent's email address, study programme, year of birth, gender, nationality, and secondary-level education. These data were included as background variables when importing the respondents into the survey application. Thus, all data were originally in digital format.

4.4.2 Response scales

As Wilson & Gochyyev (2013, p. 11) note, the primary purpose of a questionnaire item is to prompt for a response from the respondent. In a self-report questionnaire, presenting a question or statement item is like a dialogue between the researcher and the informant. As opposed, for example, to the interview setting, a questionnaire item, however, only offers a "one-off" procedure containing only one round of question or statement and response. The researcher lacks visual or other cues to assess whether the respondent has understood the item, and the respondent does not have the opportunity to ask any clarifying questions. Responding truthfully to the prompt is possible only when the respondent understands the question or the statement and interprets it to have the same meaning as intended by the researcher. This, in turn, requires that the respondent possesses the necessary information and/or experience about the topic. If this is the case, we can expect the response to correspond with the respondent's actual position regarding the statement. However, if the respondent does not have the necessary information and/or experience (and the item is compulsory), the response will be fake, and the registered value will not express the respondent's true position.

In the questionnaires in the current studies, all the data were collected using self-report items offering only fixed responses on anchored scales. In general, effort was invested to make the response options as comprehensive as possible, but in addition, in order to meet the requirements described above, many items also offered some kind of escape option such as an open-ended 'other, please specify'.

In the survey Me, ICT and media (Appendix 4), most topics were about various ICT tools and services, and the items were about reporting one's frequency of use or assessing one's skills on anchored scales. Where possible, the conditionality feature of the online survey was utilised; that is, the topic was split so that the respondents were first asked if they had experience of the topic and only if they reported possessing the required experience, were the detailed questions regarding the topic displayed.

The survey Me and my knowledge consisted of statements about knowledge and knowing, presented using a 6-point anchored disagree-agree scale. Among researchers, there seems to be some disagreement about offering the non-substantive 'don't know' option, and some researchers (e.g., Martin, 2005, p. 728) even discourage from offering a non-substantive option. Not offering a 'don't know' option is, however, comparable to asking about some activity and offering a frequency scale ranging from, e.g., 'several times a day' to 'once a year', and not

offering the 'never' option. As opposed to Martin's stance, for instance, Wilson & Gochyyev (2013, p. 15) suggest that non-substantive options can be used for investigating potential reasons for missing responses with the aim of improving the items.

Many statements in the epistemic survey were rather abstract and since the survey also contained several new items, there was a special challenge and interest in assuring that the respondents provided a substantive response only if they understood the question and were capable of having an opinion. For example, Wood & Kardash (2002, p. 244) received comments from the respondents about some items being difficult to understand. Thus, it was important to collect information also about the quality and the comprehensibility especially regarding the new items. Consequently, the epistemic items were presented with both the options 'don't know' and 'don't understand the question' (Figure 3). In order not to distort the visual midpoint of the scale, the non-substantive options were placed on each side of the actual scale (cf. Tourangeau et al., 2004).

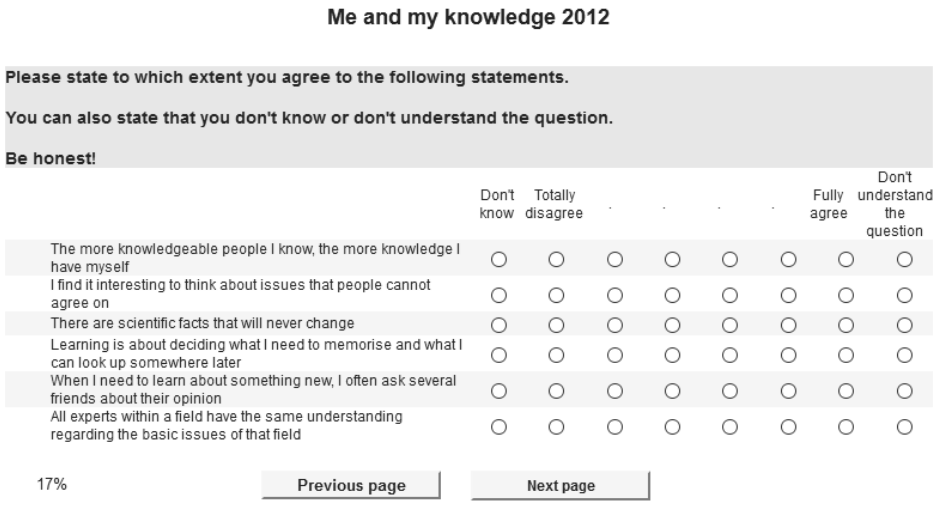

Figure 3. Sample screenshot showing the anchored scales used to present the epistemic items.

A high portion of 'don't understand the question' responses was expected to indicate an unclear or incomprehensible phrasing, whereas a high portion of 'don't know' responses would indicate that the statement phrasing is comprehensible, but the respondent is, for some reason, not capable of taking a stand.

4.4.3 Questionnaire presentation

Both questionnaires as well as the ICT Driving License level test were administered online and, in both the questionnaires and tests, the questions and statements were distributed over several pages. Distributing the items over several pages imitates item presentation in the paper-and-pencil format. The more important reason for pagination is firstly, that presenting all questions on one single, long page, can easily exhaust or demotivate the respondent. Secondly, paginating the items in an online questionnaire enables saving the responses as the respondent walks through the questionnaire. Thus, even if the respondent interrupts responding, at least a part of the responses is saved. Thirdly, pagination enables using the conditionality feature so that, for example, only if the respondent reported possessing a smartphone, the next page with questions regarding smartphone use were displayed.

Pagination also allows setting up the questionnaire items to meet the requirements of the specific data collection. For example, in the survey Me, ICT and media, the items were grouped thematically around specific topics such as mobile phones, which reduces the cognitive load and helps focusing on the topic. In contrast, in the epistemic survey Me and my knowledge, the order of the items was randomised so that each page contained statements that were associated with different epistemic dimensions, and in addition, the order of the pages was randomised. This double randomisation minimised the risk of so-called context and order effects, or individual items influencing the responses on adjacent or subsequent items (cf. Couper et al., 2001; Tourangeau et al., 2004).

4.5 Population and sampling frame

The population of interest consisted of young people as described in the introductory anecdote. At the time of data collection young people just entering university studies coincided with the so-called net generation of millennials and digital natives, born between the mid-1980s and mid-1990s. Thus, they were in their 20s, that is, young people in the transition from adolescence to young adulthood, and at the same time from secondary-level school to tertiary-level higher education. In that situation it was reasonable to assume that some part of the population would exhibit characteristics resembling the so-called digital natives (see Section 2.1.1).

The population of interest actually consisted of all young Finnish students entering their university studies at the time of data collection. In Finland, around

36,000 students entered a university of applied sciences both in 2011 and 2012 (OSF, 2022a), while the corresponding annual numbers for bachelor-level programmes at the science universities were just over 15,000 (OSF, 2022b). Reaching out to such a broad population would only be possible within a large research project coordinated by some national educational authority. When considering the sampling frame, it was therefore important to consider the requirements for statistical analyses.

Based on the arguments above, a convenience sampling was chosen so that in the present studies, the sampling frame consisted of first-year students starting their bachelor-level studies at one single university of applied sciences in the metropolitan area. The first-year status was not a priority in itself but instead, this group was selected based on the assumed uniform secondary level background and for practical reasons in terms of availability for data collection. In the Finnish educational system, universities of applied sciences provide post-secondary education at bachelor and master level. To qualify for either a science university or a university of applied sciences, the students must have undergone a nine-year primary education and a three-year secondary education. The secondary education can be completed either at a vocational institution or at a so-called upper-secondary school (*gymnasium*, see infographics in MinEdu, 2018, p. 3). The university in this thesis attracts students from both rural and urban Fenno-Swedish regions and, as all Finnish universities, also international students. On the bachelor level, the university had an annual admission rate of around 500 students and offered 14 study programmes covering a broad range of fields. Using the planned sampling frame, a single annual cohort would constitute about 1% of the first-year students on national level (1.4% within universities of applied sciences). Although the versatility of study programmes spoke in favour of it, the sampling frame would not provide a representative sample, mainly owing to the university being a university of applied sciences but also because the sampling frame mainly represents the Fenno-Swedish regions.

4.6 General sample and data descriptives

Invitations to participate were sent to 557 students in 2011, and in 2012 the procedure was repeated by inviting 481 students. Out of 1038 students representing all study programmes, 916 participated in at least one survey or in the level tests. Most but not all students participated in the collection of all three data sets. Thus, as illustrated in Table 2, the overall participation was slightly higher than the response rate in each of the surveys and the level tests.

Table 2. Sampling frame, sample, participation, and response activity in each survey and in the ICT Driving License level tests.

Data set \ Cohort	2011	2012	Total	Response rate
Me, ICT & media	453	409	862	83.0%
ICT Driving License level tests	460	434	894	86.1%
Me and my knowledge	397	371	768	74.0%
Invitations (sampling frame)	557	481	1038	
Participants (sample)	476	440	916	
Overall participation	85.5%	91.5%	88.2%	

The sample in this study consisted of 59% (57.4%)[8] female[9] respondents, and out of all respondents, 86% (84%) were domestic (Finnish) and 14% (16%) were international, representing 33 nationalities. The age of the respondents varied between 17 and 49 years, where two thirds of the respondents were between 19 and 21 years of age, and about 95% were younger than 30 years of age. Thus, the age median was 21.0 (21.0) whereas the mean age was 22.0 (22.2). The majority of the respondents or 67% (65.0%) had completed their secondary level education in a general upper secondary school, whereas 12% (11.8%) had completed a vocational education (cf. MinEdu, 2018, pp. 3, 17–18). Further, 12% (14%) had completed their secondary level education in a foreign secondary-level school and for 9% (9.2%) the information was missing. It is worth noting that, although the vast majority had undergone an upper secondary or a vocational education, not all students enrolled at the university directly after their secondary education; 41% had been studying (mainly at secondary level), but 36% had been working and 23% had been doing 'other'. Within the sample, the study programmes were represented in almost the same proportion as in the sample frame (average deviation 0.5% units).

To sum up, regarding demographics, the sample was close to the sampling frame but not to be regarded as representative of the population. Still, the sample was broad enough for the aim of this thesis, that is, an initial statistical exploration of possible associations between ICT practices, epistemic beliefs, and internet reliance.

[8] The numbers in parentheses represent the sampling frame.

[9] Data regarding gender were obtained from the student registry which, at the time of data collection, contained only the binary gender values female/male.

Figure 4 presents an overview of which data subsets were used in the various analyses, which analysis methods were used, and in which studies the results were published. The ICT Driving License level test scores, the ICT practices and the clusters that built on these were based on the entire data set, but the test scores and the clusters were used only in Study I. Due to failed replication of the FEE-specific dimensions (see Section 4.3.2), the analyses in Study II involving epistemic beliefs are based solely on data collected among the 2012 cohort. Consistently, the analyses in Study III are also based on data collected among the 2012 cohort.

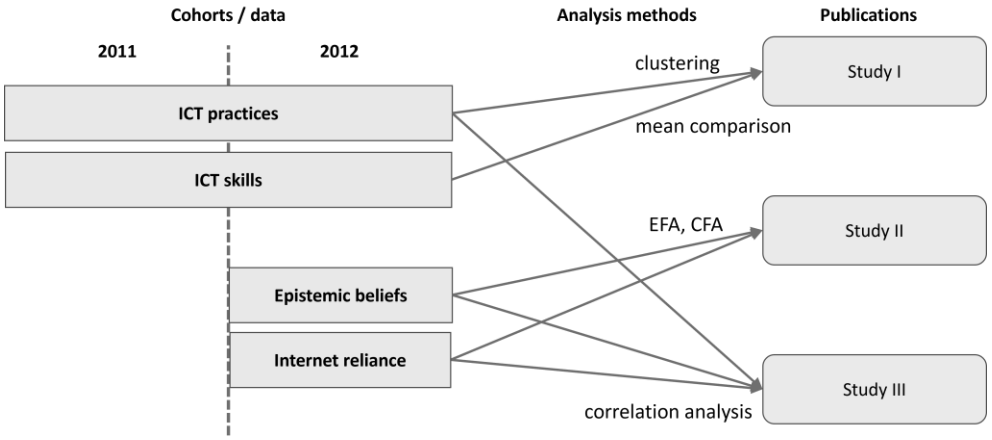

Figure 4. Overview of cohorts, data sets and analysis methods used in each study.

4.7 Analysis methods

The items presented in the various questionnaires are operationalisations of the central concepts or what Wilson & Gochyyev (2013, p. 8, with reference to Nunnally) call an explication of the construct, in other words, making an abstract concept explicit in terms of observable variables. Each concept is initially hypothetical and needs to be tried out with respondents (Wilson & Gochyyev, 2013, p. 10). One method of doing this is by using exploratory factor analysis which, as Osborne et al. (2008, p. 97) note, is an expressly exploratory procedure, and which may result in the hypothesised constructs (factors), or in quite other constructs, which was the case in Study II. The model extracted in exploratory factor analysis may then be verified by internal replication involving both exploratory and

confirmatory factor analysis[10]. Another method of testing a hypothesised concept would be clustering. In Study I, clustering was applied without any hypotheses regarding either the number of clusters or their characteristics. Instead, the clusters emerged from the material, that is, based on the use patterns describing ICT practices.

As illustrated in Figure 4, data were collected among two cohorts of students, but the analyses were performed on different subsets, as explained in more detail in the following sections. The collected data were univariate data that were used as input in multivariate methods such as clustering and exploratory factor analysis, or to generate new computed subscales. One-way Anova and correlation analysis were used to compare the data across groups. The analyses were performed using version 24 of the AMOS and SPSS software packages (SPSS, 2016a, 2016b) and throughout the analyses and statistical tests, a significance level of 0.05 was applied.

4.7.1 Study I

In Study I, the task was to identify user typologies, and specifically to explore if and to what extent the presumed digital nativeness, as it was described in contemporary public and scientific discussions (Section 2.1.1), occurred within the sample. The analyses were performed on a subsample containing those students who had completed both the survey Me, ICT and media and the ICT level tests (n=768). In order to reduce the effect of confounding variables, this subsample was further reduced to domestic students born after 1979, (n=715, corresponding to 78% of the 2011-2012 samples, cf. Table 2). This subsample was assumed to be more uniform in terms of age, culture, ethnicity, and socioeconomic background, including ICT and media resources.

The survey Me, ICT and media included items describing use frequencies regarding computer use, various internet activities, mobile phone activities, blogging, and news media use. In order to serve cluster analysis, a set of use pattern subscales was created, capable of distinctly expressing each use pattern. Thus, the use pattern subscales were created by combining conceptually connected items (e.g., activities expressing versatile phone use), and using the MEAN.x function to compute the subscale scores as unweighted averages of the corresponding item values (cf. Hair et al., 2010, pp. 126–128). The MEAN.x function was preferred since it never produces a score based on a single response, but instead it produces a score only for those

[10] exploratory and confirmatory factor analyses hereafter denoted as EFA and CFA, respectively.

cases where a required number (x) of valid values is available for each case (SPSS, 2016b). The number of required values was set to x=(n-1) where n is the total number of corresponding variables but with the condition x≥3. The advantage was that subscale scores were generated only for cases with almost complete responses.

The previous step resulted in use patterns expressed as subscales, and the subscale scores were then used as input variables in Two-step Cluster Analysis. In the last step, the ICT level test scores were compared across ICT user clusters using the One-Way Anova test.

It may be mentioned here that, during the process, the focus was slightly shifted such that the clusters and the level test scores were not utilised outside Study I and instead, only the use patterns from Study I were utilised in Study III (see Figure 4).

4.7.2 Study II

In the second study, the ambition was to extend existing self-report instruments for measuring epistemic beliefs in such a way that it would be possible to identify variations in the googling approach. The 2012 version of the survey Me and my knowledge yielded a sample with 371 responses (Table 2, p. 58). Since the data set was going to be subject to EFA and CFA, only those cases containing more than 70% substantive item responses were retained for the analyses (n=348, corresponding to 93.8% of the 2012 sample).

In some of the earlier studies (e.g., Schommer, 1990; Schraw et al., 2002), the dimensions were not expected to correlate. Still, for example, Wood & Kardash (2002, p. 252) and Otting et al. (2010) found inter-factor correlations, and Wood & Kardash also urged caution not to allow factors to correlate, as it may hamper attempts to find a factor structure. Consequently, in Study II, the factors expressing epistemic dimensions were allowed to correlate.

A series of EFA was first performed separately on the two subsets of items associated with the original EQ dimensions (Schommer, 1990, 1993, 1998) and the hypothesised dimensions (Section 2.2.2), respectively. For the original EQ items, this served a replication purpose, and for all items it provided information about item functionality.

As a next step, the complete item set was subjected to a series of EFA. Since inter-factor correlation occurred in the previous analyses, Maximum Likelihood was used as extraction method and Promax or Oblimin as oblique rotation methods (as also recommended by Finch et al., 2016, p. 133; Knight et al., 2017; Osborne et al.,

2008, p. 90; Strømsø & Bråten, 2010). The model was stepwise refined by removing low-loading and cross-loading items while simultaneously assessing their conceptual relevance, their communality estimates and their internal consistency within the anticipated scale. Throughout the analyses, the absolute value 0.32 was used as the threshold when assessing item loadings (cf. Finch et al., 2016, p. 143).

The refinement procedure produced a seven-factor model based on 26 items. In the next step, the model arrived at was evaluated using internal replication, that is, by splitting the data set into two equally sized and randomised halves which were then subject to EFA and CFA, respectively (cf. Fokkema & Greiff, 2017, p. 401).

The EFA on one split half data subset produced a model that resembled the initial model strongly, with 22 out of 26 items loading as anticipated. CFA was performed on the same 26 items as the previous EFA but on another split half data subset. In the first step, conceptually irrelevant and low connections between latent variables were removed, which resulted in an initial model with partly insufficient fit indices. Assessing model fit and choice of cut-off criteria followed the recommendations by Schreiber et al. (2006) and Hooper et al. (2008). Since the data set had not been imputed with estimated values it contained empty cells, and thus it was not possible to let the analysis software provide suggestions for modification (SPSS, 2016a). Therefore, model refinement was performed manually, partly following loadings and correlations indicated in the previous EFA models, and partly by adding and removing connections based on conceptual considerations in an exploratory manner.

4.7.3 Study III

In Study III, I switch focus back to the overall aim of the thesis about the googling approach possibly expressing a changed way of viewing knowledge, knowing, and learning, and further, if and to what extent this approach, expressed in the internet reliance dimension, is associated with the individual's epistemic beliefs and ICT practices.

Utilising the concepts described in the previous studies, Study III applied correlation analysis to explore if and to what extent there are associations between 1) users' epistemic beliefs, 2) their internet reliance, and 3) their ICT practices. It is worth noting that Study III inherits some of the limitations of the preceding studies since both internet reliance and ICT practices are tied to the contemporary societal and technological environment.

Studies I and II were expected to provide the constructs required in Study III (see Figure 1, p. 41). Owing to the EFA applying listwise deletion, the factor score generation in Study II reduced the number of available cases to 195. Thus, comparing the factor scores across the clusters generated in Study I would have reduced the number of available cases even more.

For the reasons above, instead of clusters, Study III utilised the subscale scores describing six distinct ICT practices that were already available as a result of Study I. Instead of epistemic dimension and internet reliance factor scores, subscale scores based on the factor model were computed (cf. Hair et al., 2010, pp. 126–128). Similar to the ICT use pattern subscale scores in Study I, the subscale scores describing epistemic dimensions and internet reliance were computed as unweighted averages of the corresponding items using the MEAN.x function (SPSS, 2016b). As in Study I, the number of required values was set to $x=(n-1)$ where n is the total number of corresponding variables and with the condition $x \geq 3$. Thus, it was possible to include the whole 2012 sample (Table 2, p. 58), and using the MEAN.x function allowed computing a subscale score for internet reliance and each of the epistemic dimensions for the majority (between 326 and 334) of the 440 cases in the 2012 sample.

4.8 Ethical and integrity considerations

The study was part of the university's strategic development project that aimed at developing teaching and learning at the university. According to contemporary university instructions, the research plan was reviewed and approved by the university's ethical board after recommendations from the university's pedagogical expert group and the university's research and development board. Due to the study being part of a university project, it was possible to obtain background data from the university's student registry. To enable data merger, the students' email addresses were retained as identification data in all the original data sets until the 2011 and 2012 data sets had been merged. After that, the merged data set was anonymised by removing the email addresses, and the original data sets were destroyed. Throughout the process, all data sets have been stored on the university's storage devices, accessible only by the researcher's personal login.

The purpose and use of the background variables and the collected data sets was declared in the Research Data File Description (Appendix 2) that was set up in accordance with the contemporary Finnish Personal Data Act (L 523, 1999) and the

ethical principles proposed by the National Advisory Board on Research Ethics (TENK, 2009). Both the email invitations (Appendix 1), the Research Data File Description (Appendix 2) and the information sheet provided at the scheduled sessions (Appendix 3) declared that participation was voluntary and that analyses were to be performed on anonymised data.

The information provided to the informants orally and in writing (Appendices 1-3) aimed at motivating the students while at the same time assuring them that participation was voluntary. A strong argument for students to participate was that their responses would contribute to development of their teaching. Still, since teachers always have a position of power in relation to students, the line between motivating and demanding is delicate and requires some kind of expressed consent.

Informed consent is often obtained by collecting written signatures from the respondents, which per se does not guarantee that the respondents have understood how data will be used, nor that they are participating out of free will. Unfortunately, the web service used for data collection did not provide the (currently common) feature where the respondent can access the questionnaire only after checking a checkbox and thereby providing consent that data can be used according to the Research Data File Description. Since the research did not intervene with the research subjects' personal or physical integrity, it was not deemed necessary to collect signed consent declarations. Instead, the respondents were informed that by performing the action of responding to the surveys, "… their behaviour [is] interpreted to mean that they have given consent to participate", thus adhering to the contemporary guidelines of the National Advisory Board on Research Ethics (TENK, 2009, p. 5). It is worth noting that, in the current guidelines, electronically provided consent is equated with written consent (TENK, 2019, pp. 9–10, 18).

In 2016, the General Data Protection Regulation (GDPR, 2016) came into force introducing, firstly, the requirement for a legal basis for processing personal data, and secondly, a clarification of the participant's right to withdraw from the study. Although the GDPR was not in force at the time of data collection, the Research Data File Description (Appendix 2) contained largely the same information as would be included today in a so-called Privacy Notice for Scientific Research according to the GDPR. In general, the data collection procedure was largely in accordance with what was later regulated in the GDPR, indicating that the contemporary Finnish Personal Data Act (L 523, 1999) and the contemporary ethical principles proposed by the National Advisory Board on Research Ethics (TENK, 2009) anticipated the basic values that were later established as part of the GDPR.

5 OVERVIEW OF THE RESULTS OF ORIGINAL STUDIES

In this section, I report the central results of the original studies by responding to and commenting on the research questions guiding each of the original studies. The three original studies were all based on the same data set provided by first-year undergraduates, albeit on different data subsets and subsamples, as illustrated in Figure 4 (p. 59).

5.1 A part of the students resemble digital natives (Study I)

This study aimed to contest the common assumptions of an ICT savvy net generation, which raised several questions to be explored:

- What groups can be identified based on users' ICT practices?
- To what extent can groups within the young generation be regarded as digital natives or native-like?
- What are the actual, performance-based ICT skills on the one hand among young people in general, and on the other, compared across the groups identified?

The following were the key findings of Study I:

- Among the clusters, only two clusters resembled so-called digital natives. The results further showed that the other three clusters did not resemble digital natives in terms of either ICT practices or ICT proficiency.
- The performance-based ICT skills scores exhibited inter-cluster differences in all modules (module 1: $F(4, 333)=20.27$, $p<.001$; module 3: $F(4, 681)=12.18$, $p<.001$; module 4: $F(4, 678)=6.81$, $p<.001$; module 5: $F(4, 330)=23.81$, $p<.001$). Although these differences were found between clusters in the mean values, it is worth noting that the test scores ranged over the whole scale within all clusters (see Figure 4 in Study I).

Based on ICT and media use patterns, five distinct clusters were identified, and the five-cluster model was deemed as optimal since it contained rather equally sized and distinct clusters. The emerging clusters were labelled *Low-end users, Bloggers, Communication-oriented users*, *Gamers*, and *High-end users*, out of which only the two latter resembled digital natives.

ICT skills were measured using the performance-based ICT Driving License level tests. Taking into consideration both the ICT and media use patterns as well as performance-based ICT skills, only the cluster labelled High-end users corresponded to the common conception of digital natives. The cluster labelled Gamers, which actually outscored High-end users in performance-based ICT skills, was assessed as digital native-like. These two clusters represented 16% and 18% of the sample, respectively. The remaining three clusters were assessed as not corresponding to the descriptions of digital natives.

The most central result of Study I is that it demonstrates the heterogeneity among the sample regarding both ICT practices and performance-based ICT skills and dismisses assumptions about an ICT savvy generation of digital natives.

5.2 Internet reliance as an epistemic dimension (Study II)

The original dimensions introduced by Marlene Schommer in her Epistemic Questionnaire (EQ; 1990, 1993, 1998) – certainty of knowledge, structure of knowledge, omniscient authority, learning ability and learning speed – appeared in many of the successors to EQ (Table 1), but it was obvious that the original dimensions were not capable of capturing how individuals relate to internet-based information.

Previous instruments were extended with new dimensions to capture how an individual relates to internet-based information. The intention was expressly to retain the original dimensions in order to also explore how these relate to the possible novel dimensions. The extended instrument included both knowledge-oriented and learning-oriented dimensions, and the research question in Study II reads:

- How can the set of dimensions of epistemic beliefs be extended so that it also expresses a googling approach and/or a reliance on internet-based information?

Key findings of Study II:

- In addition to four of the original EQ dimensions, the epistemic beliefs model was extended with three novel dimensions labelled *Constructivist approach to learning*, *Learning by dialogue* and, most importantly, the dimension of *Internet reliance*.
- The original dimensions omniscient authority, structure of knowledge and certainty of knowledge correlated weakly or moderately[11].
- The learning-oriented dimensions of learning ability, constructivist approach, and learning by dialogue correlated weakly or moderately.

In the 26-item model arrived at in Study II, four original dimensions replicated successfully, whereas the six hypothesised dimensions were reduced to three, hereafter collectively referred to as novel dimensions. In the proposed model, all dimensions appeared stable throughout the subsequent internal replication procedures applied on the split half data subsets. Further, both the original and novel dimensions appeared distinctly almost without cross-loadings, each factor loaded (>0.32) on at least 3 items, each factor contained a marker variable loading over 0.60, and all items except one loaded on the anticipated factor (see Table 3 in Study II).

Considering the research question, the most central result of Study II is the novel dimension internet reliance, consisting of three items, all expressing a reliance on and a belief in the superiority of internet-based information (see Study II, Table 3). The items were oriented such that they expressed a similar kind of uncritical stance as the items expressing the original dimensions, in much of the earlier literature referred to as a naïve orientation.

5.3 Internet reliance goes hand in hand with naïve epistemic beliefs (Study III)

Study III focuses back on the overall aim of the thesis by exploring if and to what extent the googling approach, expressed in the internet reliance dimension, appears differently depending on the individual's epistemic beliefs and ICT practices. The three research questions in Study III are collectively expressed as: What are the associations between students' 1) epistemic beliefs, 2) internet reliance and 3) ICT practices, respectively?

[11] verbal descriptions of correlations (weak – moderate - strong – perfect) according to Coolican (2014, p. 524)

The key findings of Study III:

- The analysis revealed moderate or weak positive correlations between all three dimensions of epistemic beliefs and internet reliance.
- The moderate positive correlation between internet reliance and the epistemic dimension of omniscient authority may suggest that the internet is regarded as a kind of non-human authority.
- The moderate positive correlation between internet reliance and the dimension structure of knowledge may suggest a view of knowledge as simply structured and easily available on the internet.
- The results indicated a weak positive correlation between internet reliance and two ICT use patterns (Game playing and Digital news media use). Contrary to what was expected, the correlation between internet reliance and general internet activity was barely weak ($r=.146$, $p<.01$).

To focus on the specific research questions of this study, only the three knowledge-oriented original EQ dimensions (certainty of knowledge, structure of knowledge, omniscient authority) were included in the comparison, whereas the learning-oriented and novel dimensions were omitted. The epistemic dimensions and internet reliance as constructs were provided by Study II, and for the purpose of this study, the subscale scores were computed to express these constructs. The subscale scores expressing ICT practices were already available from Study I.

Considering the overall aim of the thesis, the most central result of Study III is the positive correlation between internet reliance and the dimension omniscient authority.

6 DISCUSSION

6.1 Discussion of main findings

The initial research question of this thesis was to explore if and to what extent the googling approach goes hand in hand with frequent ICT use, and if it expresses a new way of viewing knowledge, knowing, and learning. In more specific terms, the research task was to explore to what extent ICT practices, epistemic beliefs and internet reliance are associated. Out of the original studies, the first two produced input for the third study. In this section, the main findings are discussed.

The most interesting outcome of the thesis is the positive correlation between three dimensions of epistemic beliefs and internet reliance. This responds affirmatively to the initial research question of the thesis. This association indicates that a higher level of internet reliance goes hand in hand with a (naïve) view of knowledge as certain, absolute, and unchanging, as consisting of unambiguous, isolated bits, and basically being handed down by authority. As a consequence, and considering the ubiquitous access to information, this further indicates that, among users with a tendency to more naïve views of knowledge, convenience may override critical scrutiny, as suggested in previous research (e.g., Biddix et al., 2011; Alexander & The Disciplined Reading and Learning Research Laboratory, 2012). Knowledge construction can be replaced by fast searches, and as Sundin et al. (2017) describe it, for many users everyday life is more or less a continuous series of internet searches. When convenient access passes source critics in the background, we may perhaps not talk about what is commonly understood as knowledge construction but rather, a cumulative collection of detached bits of information that can be either true or false.

Within this finding, the correlation between internet reliance and omniscient authority is of special interest since it suggests a trust in a non-human, algorithmic authority. The observable expression for this can be that some respondents regard the search engine, or perhaps the internet itself, as a knowledge authority, a trusted source of knowledge. This can be compared to students using natural language questions in the search box as if posing the search question to a real person, as reported recently in the review study by Zlatkin-Troitschanskaia et al. (2021).

Recalling the definition of algorithmic authority – "the trust in algorithms to direct human action and to verify information, in place of trusting or preferring human authority" (Lustig & Nardi, 2015) – gives us a hint of the potential risks. Students might allow non-human epistemic agents to direct their action and to verify information. If their awareness of the limitations, biases and intentions of the epistemic agent are insufficient, the situation turns problematic: how will the user assess and justify information, that is, testimonies, found on the internet? The current material is, however, not capable of answering questions about 1) the extent to which users identify the source behind the information (testimony), 2) the extent to which users allow the algorithmic authority to influence their decisions, or 3) the grounds for trusting the (algorithmic) authority. Responding to these questions requires data collection methods that frame the context of discourse to enable more fine-grained measurement (cf. Chinn et al., 2011). Data collected, for instance, by observation, think-alouds or interviews would allow going more in-depth into the respondents' justificatory reasoning (see Section 2.2.2).

Within the concept of epistemic beliefs, a central outcome was that the set of epistemic dimensions, as originally described by Schommer (1990) and several successors (Section 2.2.2), was extended with three novel dimensions. Out of these, the most interesting is the dimension of internet reliance, expressing a reliance on internet-based information. As discussed in the beginning of this section, this dimension was essential for answering the initial research question of the thesis.

By introducing the three novel dimensions of constructivist approach, learning by dialogue and internet reliance, the proposed model contained both knowledge-oriented and learning-oriented dimensions. The dimensions of constructivist approach to learning and learning by dialogue both resemble the dimension of knowledge construction and modification suggested by Wood & Kardash (2002) and the dimension of collaborative knowledge-building recently suggested by Lonka et al. (2020). According to several researchers (e.g., Hofer & Pintrich, 1997; Sandoval, 2009), learning-oriented dimensions are, however, not to be regarded as true dimensions of epistemic beliefs. On the other hand, Sandoval (2009) states that theories of personal epistemology should also account for how beliefs about knowledge and knowing relate to beliefs about learning. The novel dimensions are also interesting since they are inter-correlated, as was the case with the (original) knowledge-oriented dimensions. Conceptually, this might suggest the existence of two latent second-level variables. The novel dimensions of learning by dialogue, constructivist approach to learning, and internet reliance are examined further as part

of the discussion concerning the theoretical implications for epistemic beliefs research (Section 6.2).

At the time of planning the studies and the data collection, the debate surrounding so-called digital natives was still prominent, although it was also criticised and contested (see Section 2.1.1). A central finding of Study I is that the results confirm the heterogeneity among the students, and that only around a third of them resembled so-called digital natives. A further important finding of Study I was that also within all the emerging clusters, including those resembling so-called digital natives, the users' performance-based ICT skills ranged almost over the whole scale. Taken together, these results corroborate previous studies that dismiss the hype and narrative surrounding so-called digital natives (cf. Best & Kellner, 2003; Judd, 2018; Kennedy et al., 2010; Kirschner & van Merriënboer, 2013; Marshall, 2018; Selwyn, 2009). Regarding ICT user clusters, it is worth noting that the extracted clusters resemble but are not identical to the clusters suggested in previous studies (e.g., Jones & Hosein, 2010; Kennedy et al., 2010; Thompson, 2013; van den Beemt et al., 2011). This confirms that the clusters are highly dependent on the input data and, specifically in the case of ICT practices, the input data are highly dependent on the contemporary ICT environment.

Although the topic of digital divide was not in the focus of this thesis, the findings may still contribute to the discussion regarding this topic. Access to ICT and connectedness are regarded to be on a high level in most western industrialised countries such as Finland, and it has been commonly assumed that physical access to ICT and internet will solve the digital divide problem (cf. van Deursen & van Dijk, 2019). The results of Study I do, however, suggest a persisting secondary-level digital divide; that is, despite physical access, all users do not manage to develop their skills equally well and not to a sufficient level for academic studies as defined for instance in the ICT Driving License (see Section 4.3.1). This, in turn, risks contributing to a tertiary-level digital divide (for a definition, see, e.g., Büchi et al., 2016; van Deursen & Helsper, 2015) where users are unable to develop meaningful ways of utilising and taking advantage of ICT. A persisting digital divide risks contributing to increasing social and intellectual inequalities among the population (cf. Scheerder et al., 2019; van Deursen & Helsper, 2015).

Contrary to what was expected, the results do not indicate any association between ICT practices and either internet reliance or epistemic beliefs. To understand what

this finding implies, it is necessary to acknowledge that only one of the technology-based activities, general internet activity, included information searching as an explicit activity. Here I assume that, among technology-based activities, information-oriented activities are most relevant for both internet reliance and epistemic beliefs. Further, the general internet activity subscale was built up out of nine different activities, out of which only three expressed information searching (Study III, Table 4). Thus, the general internet activity subscale expresses information searching only to a limited extent. Here it is important to bear in mind that at the time of data collection, smart phones were not in common use and thus, among the sample involved, everyday life was not (yet) "a continuous series of internet searches" in the way and to the extent that Sundin et al. (2017) describe it. Finally, it is worth noting that the lack of association between ICT practices, and internet reliance and epistemic beliefs, respectively, challenges earlier assumptions about a generation of digital natives possessing characteristics that would be a direct outcome of frequent technology use (see Section 2.1.1).

The overall outcome of the thesis – in relation to the initial research question and based on the collected data – indicates the following:

- The googling approach expresses an underlying internet reliance, which is associated with naïve views of knowledge and knowing.
- The association between internet reliance and the epistemic dimension of omniscient authority suggests that users may, perhaps unknowingly, regard the internet as an (algorithmic) authority.
- Besides internet reliance, the dimensions of learning by dialogue and constructivist approach to learning were identified as (learning-oriented) dimensions of epistemic beliefs.
- The results regarding ICT practices and ICT skills corroborate previous findings about the heterogeneity among the generation and dismiss the narrative surrounding digital natives.
- The results regarding ICT user groups suggest that a secondary-level digital divide still exists, which poses a risk that the tertiary-level digital divide will also deepen.
- In the current data, frequent ICT use was not associated with either internet reliance or epistemic beliefs.

6.2 Theoretical implications

The theoretical implications of the studies focus on three concepts and their associations: 1) ICT practices, ICT user groups and digital natives, 2) the dimensions of epistemic beliefs, and specifically 3) internet reliance as a dimension of epistemic beliefs.

The concept of digital natives was never an established nor well-defined theoretical concept. The results corroborate previous studies that dismiss the hype and narrative surrounding digital natives (cf. Best & Kellner, 2003; Judd, 2018; Kennedy et al., 2010; Kirschner & van Merriënboer, 2013; Marshall, 2018; Selwyn, 2009). Thus, this thesis contributes to confirming the vagueness of digital natives as a concept and that operationalising the concept may lead to misleading generalisations (see Section 2.1.1).

Based on the results and previous studies (e.g., Jones & Hosein, 2010; Kennedy et al., 2010; Thompson, 2013; van den Beemt et al., 2011) we can further conclude that a conceptualisation and categorisation of ICT practices, users, and user groups (such as digital natives) is difficult, mainly owing to the character of ICT itself. Due to technological development, the ICT and media environments are constantly changing, and as mentioned earlier (Section 2.1.2), ICT practices and the ICT environment are mutually dependent and influence each other. Tools, applications, and services are constantly changing, and thereby also the practices and concepts. For instance, at the time of data collection, internet-connected phones existed but only on a small scale, and services and applications were in the bud. Therefore, it was not possible to ask the respondents about *smartphones* since the term was not yet commonly known.

Thus, we can regard the concepts of ICT practices and ICT users as moving targets, which makes conceptualisation and consistent measurement almost impossible, or at least bound to specific ICT contexts and points of time. Conceptualisation and measurement should strictly consider the ICT and media environment in which measurement is performed, and for what purposes measurement and possible categorisation is performed.

The over-arching theoretical implication regarding the epistemic beliefs concept is that researchers may have reason to reconsider the frequently applied dimensional structure originally suggested by Hofer & Pintrich (1997), with 1) the nature of knowledge containing structure and certainty of knowledge, and 2) the nature of

knowing containing source of knowledge and justification for knowing. Justification for knowing is definitely a part of the concept, especially when considering its three sub-dimensions 1) justification by authority, 2) justification by multiple sources, and 3) personal justification, as originally suggested by Ferguson et al. (2013) and later validated by Bråten et al. (2019). Including this three-dimensional construct will raise the question whether omniscient authority and justification by authority are overlapping. This issue is further discussed as part of the methodological implications (Section 6.3).

Regarding epistemic beliefs as a dimensional construct, it should also be considered if the commonly applied dimensional structure is sufficient for describing all aspects of epistemic beliefs (cf. Section 3.2). Could the conceptualisation include the suggested dimensions of constructivist approach to learning and learning by dialogue, perhaps together with the original dimension of learning ability? The first two dimensions both represent a learning aspect not expressed in the original EQ dimensions (see Section 2.2.2), namely learning as a social process. In this social process, interaction with others is central, regardless of whether the others represent convergent or divergent opinions. The similarity to "… the widest possible spectrum of points of view…" as a scholarly approach is obvious, although Downes (2007, p. 99) and Siemens (2006, p. 16) describe it as an aspect of what they call connective knowledge. Both dimensions show similarities to the dimension of knowledge construction and modification suggested by Wood & Kardash (2002) and the dimension of collaborative knowledge-building recently suggested by Lonka et al. (2020). Although these dimensions are learning-oriented and thereby not purely epistemic, they still provide an advantage in expressing how beliefs about knowledge and knowing relate to beliefs about learning, as suggested by Sandoval (2009). This is highly relevant considering that within the educational context of the thesis, ideas about learning and ideas about the nature of knowledge and knowing are both theoretically and practically connected.

As a dimension of epistemic beliefs, internet reliance poses a knowledge aspect not covered by the previous instruments (Table 1, p. 31) upon which the current instrument was based. Internet reliance resembles the dimension of general internet epistemology suggested by Bråten et al. (2005) and expresses the ad hoc googling approach referred to previously (Sections 2.1 and 2.2). Whether internet reliance is defined as a genuine dimension of epistemic beliefs, or a closely related construct is an open question. In the development of the questionnaire in Study II, internet reliance was operationalised as a dimension of epistemic beliefs, whereas in Study III, it was regarded as a personal trait. Regardless, the concept of internet reliance

may serve a purpose as a meter when charting the confusion between knowledge and information, which arises with the ubiquitous access to information (Fisher et al., 2015). This problem accentuates as technology develops and besides storage, also information processing is outsourced or offloaded, thereby changing our epistemic practices (Säljö, 2012; Sparrow et al., 2011; Sundin et al., 2017).

6.3 Methodological implications

Several authors (e.g., Buehl et al., 2002; DeBacker et al., 2008; Grossnickle Peterson et al., 2017; Hofer, 2000; Muis et al., 2006) have suggested that measuring epistemic beliefs should be connected to contextual elements. The issue regarding the concept of epistemic beliefs being context-specific or general (decontextualised) is basically theoretical. However, during the analyses of the current material, several incidental findings indicate that measurement problems could be traced back to the decontextualised setting, and therefore, I discuss context-specificity here, as a methodological implication. In the following, I discuss 1) various observations that indicate problems owing to items that lack a contextual connection. Further, I discuss issues regarding 2) the dimension of omniscient authority, 3) internet-based information and non-human agents, 4) justification as a dimension, and 5) source of testimony as a contextual element. The presentation concludes with a suggestion about how to overcome some of the observed problems.

Comparing the anticipated items (Study II, Table 1) and which of them were included in or discarded from the emerging EFA model (Study II, Table 3) reveals that several of the discarded items refer, explicitly or implicitly, to undefined settings; that is, the items lack contextual elements. Thus, when lacking information about the setting, the respondents may have 1) found these items difficult to understand, or 2) difficult to respond to ("…well, it depends on…"), or 3) responded to these items with quite different contextual backgrounds in mind, perhaps influenced by their very different past year activities (see Section 4.6). Responding to the items against different contextual backgrounds may have caused a noise[12] in the data that contributed to blurring the analysis results. Internet reliance correlated with all three original epistemic dimensions (omniscient authority, certainty, and structure of knowledge) albeit not as strongly as expected, which may also be a consequence of

[12] When using the term noise, I am associating to Shannon's & Weaver's description of noise as "unwanted additions" (Shannon & Weaver, 1963, p. 18)

some noise in the collected data. Items having higher rates of non-substantive responses (see Section 4.4.2) may also suggest that, owing to a lacking setting, these items may have appeared too abstract and therefore difficult to respond to (for instance, "There are truths that will always stand", or "Learning is about deciding what I need to memorise and what I can look up somewhere later").

Several earlier studies (see Section 2.2.2) have failed in capturing the dimension of omniscient authority, which can be seen as an expression for the challenge to respond without knowing the setting. This dimension has focused on authority as the source of knowledge, but inspecting the individual statements (Study III, Table 2) reveals that as a result of the decontextualised setting, taking a position on them is probably almost impossible (for instance, "I seldom or never question authorities", or "Teachers are almost always right"). Further, in these statements, it is not clearly expressed what the source would be at the other end of the scale; that is, if you do not agree to omniscient authority being the sole source of knowledge. If the other end represents knowledge by personal reasoning, then the other pole of the omniscient authority dimension might be covered by the ISEJ dimension of justification by authority (see Bråten et al., 2019), as suggested previously (Section 6.2). Furthermore, since testimony, perception, inference/reason, introspection, and memory are considered as routes to (or sources of) knowledge (Section 2.3.2), the dimension label "source of knowledge" can be questioned. A remedy for these issues would be to replace the two dimensions of source of knowledge and justification for knowing with the three ISEJ subdimensions for justification for knowing. This would also be in line with the suggestion by Chinn et al. (2011) to talk about source of testimony. Thus, the information contained in the testimony is what requires to be justified, and the source of testimony would be a contextual element, influencing the choice of method for justification.

Epistemic beliefs in relation to internet-based information has attracted attention for more than two decades already, but after all, epistemic beliefs are in no way specific to the internet era. As long as human beings have learned from the testimonies of others, they have probably possessed subconscious epistemic beliefs that influence how they assess and react to what others tell them. On the other hand, we cannot deny that the easy and ubiquitous access to information, not to mention social media and artificial intelligence, poses quite new challenges for how individuals manage and construct their personal knowledge. When scrutinising the statements used to express internet reliance (Study III, Table 3), it becomes obvious that also internet reliance should be measured at a more fine-grained level (cf. Chinn et al., 2011). The internet is not a uniform or definable context but a multitude of spaces

and voices transmitting an excessive amount of information, that is, testimonies and tellings in general that are testimonial in nature (cf. Origgi & Ciranna, 2017; Tollefsen, 2009), and require justification. Chinn et al. (2011) have suggested that "source of authority [knowledge]" should be replaced with "source of testimony", that is, the epistemic agent behind the testimony. Consequently, and since testimony is regarded as the main source for human knowledge, also the source of testimony should be considered as a possible contextual element.

The observed correlation between internet reliance and omniscient authority suggests that within the research and measurement of epistemic beliefs, the possibility of non-human agents should be acknowledged. This poses quite new challenges for the measurement setting and – when using self-reporting – for constructing the instrument. Human and non-human sources can be used as contextual elements to alter the source of testimony but in addition, measurement should also include the possibility to assess whether the user is able to identify the source behind the testimony.

One way of applying more fine-grained measurement is to frame the statements into an appropriate context (using contextual elements), which makes it easier for the respondents to relate to the statements. In their validation study, Bråten et al. (2019) measured justification for knowing so that the statements were framed in the internet context and the domain of education. Their ISEJ inventory has later been adapted for instance for general school tasks among upper secondary pupils (Hämäläinen et al., 2021) and for a socio-scientific issue among university students (Kammerer et al., 2020), in both cases in the internet context. Using testimony as a contextual element has been tested in a recent study (Ståhl, in press) where the statements were framed in 1) source of testimony, and 2) type of information. The source of testimony was either a known authority or an unknown actor on social media, whereas the type of information was either a simple fact or a piece of tentative information. The results indicated that the source of testimony had the strongest impact; that is, justification methods were used more extensively when the testimony stemmed from an unknown user on social media. A similar method for framing was recently reported in a study by Pardi et al. (2023), who investigated the influence of knowledge type (conceptual/ procedural) and source reputation on preferences for and selection of search results.

In the current studies, the questionnaires provided two non-substantive options (see Figure 3, p. 55). In subsequent studies, this method has been refined by placing the 'don't understand' option on the left side and the 'don't know' option on the right side of the actual response scale. By using the adjusted positioning, the user can

follow a logical path (from left to right) when responding to: 1) Do I understand the question? If yes, then 2) choose a point on the scale or, if unable to decide, then 3) click 'don't know'.

To conclude this section, we can connect to the concept of epistemic competence introduced by Grossnickle Peterson et al. (2017, pp. 257–258). The authors define epistemic competence as "the use of available contextual elements to determine the sources of evidence best suited for a given problem in an effort to provide an answer that is justified true belief". The authors emphasize that epistemic competence builds on the central assumptions that 1) knowledge has to be justified, and 2) the type of justification depends on the contextual elements. Thus, the key elements of epistemic competence appear as a potential remedy for some of the problems illustrated in all the aforementioned examples: measurement should include justification for knowing, and, in order to appear comprehensible, the statements should be framed in a setting, using appropriate contextual elements. Further, we cannot ignore the limitations of the one-off character of self-report surveys, where the questionnaire/researcher presents a question or statement, and the respondent responds. Thus, the researcher has no way of following up to ask about the grounds for and reasoning behind the respondent's response. To solve this problem will require a mixed method setup including qualitative methods for measurement (cf. Section 2.2.2). As in most areas, quantitative and qualitative methods do not exclude, but supplement each other.

6.4 Practical implications

The positive associations between internet reliance and epistemic beliefs confirm that the concerns I expressed in the introduction (Sections 1.2 and 2.3.1) were not unfounded. Fortunately, the goal of education on both primary (OPH, 2014) and secondary (OPH, 2019) level, and within higher education (Hyytinen et al., 2021, p. 14) include fostering skills such as critical thinking, multiliteracies, evaluation of information sources, and justification. It cannot be denied that the internet has brought much good. Still, considering that the internet and social media are such a central part of peoples' lives, regardless of age, there is a challenge for education at all levels in providing learners with the skills and tools to deal with the potentially negative impacts (see Section 1.1.1) that the internet may bring about.

One remedy to prevent the negative effects of internet reliance is probably developing both teachers' and learners' critical information literacies and epistemic competence (cf. Grossnickle Peterson et al., 2017). Further, successful education requires at least some level of consonance between teachers' and students' views of learning and learning objectives. Therefore, acknowledging both parts' views of knowledge, knowing and learning will have high relevance for educational practices at all levels of education.

When studying the relationship between epistemic beliefs and conceptions of teaching and learning, Otting et al. (2010) (albeit using different instruments than in this thesis) found a positive correlation between the view of learning as requiring effort and a constructivist view of learning. Similarly, they found a negative correlation between the constructivist view and both innate ability [to learn][13] and expert knowledge (resembling omniscient authority). In line with Otting et al., the results in Study II (Table 3) show positive correlations between the learning-oriented dimensions, especially between learning ability[13] and the constructivist approach.

Greene et al. (2018) emphasize the role of the teacher in fostering adaptive epistemic aims, which apparently builds upon the notion of the possibility of epistemic change (cf. Kienhues, 2016; Kienhues et al., 2008; Muis & Duffy, 2013). Similarly, Heikkilä et al. (2020) address the importance of teachers' epistemic agency in fostering pupils' epistemic agency. Adaptive epistemic aims may have similarities to the concept of epistemic competence. Grossnickle Peterson et al. address the need to support the development of epistemic competence, which they describe as the ability to strategically adopt varying standards of justification while considering the contextual elements at hand (Grossnickle Peterson et al., 2017, pp. 257, 261–262). Grossnickle Peterson et al. primarily associate epistemic competence to the dimension justification for knowing. It is, however, not far-fetched to interpret the concept as including the ability to apply an appropriate epistemic level also regarding the other epistemic dimensions. For instance, being aware of one's own reasoning about whether knowledge about a subject is unchanging or tentative (certainty) or consists of isolated bits or complex entities (structure).

During the past decades, the concept of constructive alignment has been widely applied within all levels of education. The key principles of constructive alignment imply that learning objectives, learning activities, and assessment tasks should all be aligned to each other; that is, they should be concerned with the same cognitive level

[13] It is important to note the opposite scale orientations here: "innate/fixed ability" as used by Otting et al. regards the ability to learn as innate and fixed at birth, whereas "learning ability" as used in Study II expresses the opposite, a notion of learning ability as something that is possible to learn and develop.

(Biggs, 2003, pp. 25–31). Constructive alignment builds upon constructivist theory and is an essential principle for instance within problem-based learning.

Bhatt & MacKenzie (2019) address the two sides of ritualisation, that is, adhering to the common practice within a field. On the one hand, ritualisation can serve an important function in introducing a new student into the practices within a discipline. In practice, this can mean sticking to an appropriately naïve approach in the novice phase, where the student is assumed not to possess enough ontological insight for personal reasoning and justification (cf. Sandoval et al., 2016, p. 465). On the other hand, ritualisation may also involve the risk that students remain stuck in such a practice, which may suppress reflection and, for instance, leave the students dependent on authorities and over-reliant on search engine results, and not realizing the potential in constructing and synthesising personal knowledge, or perhaps not developing their epistemic competence to choose the appropriate epistemic level while taking the contextual elements into account (cf. Grossnickle Peterson et al., 2017, pp. 257–259).

Building upon the aforementioned conceptualisations by Biggs (2003) and Bhatt & MacKenzie (2019), there is a potential to develop educational practices in such a way that the efforts of teachers and students meet (cf. Sandoval et al., 2016). In order to support students' epistemic competence, I would like to introduce the principle of *epistemic alignment*. Whereas, for instance, Barger et al. (2018) describe epistemic alignment as "aligning students' epistemic beliefs with the demands of the learning context", I suggest epistemic alignment rather as a principle guiding teaching practices, similar to constructive alignment. Thus, as a synthesis of constructive alignment and the teacher's own epistemic competence, epistemic alignment would be about the teacher creating learning activities (not the same as teaching), where topics are presented and learned on an appropriate epistemic level. Or, with reference to the aforementioned ritualisation, also creating learning activities where students grapple with topics on a deliberately inappropriate epistemic level. This latter approach would serve to provoke reflection upon the different epistemic levels and the importance of identifying them as part of the personal epistemic competence.

6.5 Strengths and limitations of the studies

According to Wilson & Gochyyev (2013, p. 21) errors are an unavoidable part of the measurement process and the measurer should try to reduce errors. Reducing

measurement error by providing both 'don't understand the question' and 'don't know' options can be regarded as one of the strengths in the current studies. By providing these non-substantive response options there was at least a theoretical chance to avoid the situation where those students, who did not possess the necessary knowledge or experience, did not understand the statement, or could not make up their mind, would have provided responses that do not express their true stance. Waters et al. (2022) have recently suggested (albeit in another context) that forcing respondents to choose a scaled option despite their epistemic uncertainty may introduce bias, thus reducing measurement validity. It also turned out that providing the non-substantive response options did not result in loss of data, as suggested by for instance Martin (2005, p. 728). On the contrary, providing non-substantive response options proved useful for assessing the comprehensibility and functionality of the questionnaire items. It turned out that items with high portions of non-substantive responses did not reach proper loadings in the factoring procedures, which supported the assessment of comprehensibility and functionality. To the best of my knowledge, providing two non-substantive options has not been described elsewhere, but based on the experiences referred to above, this method can be regarded as a potential methodological contribution.

A general strength in the studies included in this thesis is the open and thorough reporting of instruments and analysis results. In many publications, survey instruments are not included in their entirety, but instead, the authors only provide sample items. In the current studies, the entire instruments were reported so that, for instance, for the epistemic beliefs instrument, an extensive table (Study II, Table 1) was included, which provided an overview of the 60 anticipated items, the resulting dimensions, and which items were included or discarded, respectively. Further, when reporting the EFA models, it is commonplace to suppress low loadings, sometimes even up to 0.40. In doing so, valuable information may be withheld from the reader, for instance when an item loads just below the threshold on one or several other factors. In Study II, the threshold was set at 0.32 (as suggested by Finch et al., 2016, p. 143), and in addition, loadings just below were also displayed in order not to withhold potentially interesting information (see Study II, Table 3).

The choice to use computed subscale scores (also called summated scales) can be considered a strength since the subscale scores turned out to offer several advantages. Firstly, using subscale scores allowed the use of more items, which contributed to reducing measurement error (cf. Hair et al., 2010, pp. 126–128). Secondly, using the MEAN.x function (SPSS, 2016b) ensured that each score was

never based on only a few item values. Thirdly, the subscales applied the same value interval as the original items and were therefore easier to interpret. Finally, the use of subscale scores enabled the use of considerably more cases so that, for instance, the correlation analyses in Study III were conducted on over 300 cases (see Section 4.7.3). Computing subscale scores as unweighted means instead of factor scores can be criticised since they disregard how strongly each item loads on each factor (Hair et al., 2010, p. 128). However, the EFA model (Study II, Table 3) that was used as the basis for the subscales in Study III showed that most items loaded distinctly on the anticipated factor, and to the extent an item loaded on some other factor, the loading was mostly far below 0.2. The subscale scores can further be defended since they exhibited good internal consistency (Study III, Tables 2, 3 and 4) with Cronbach's alpha values exceeding 0.60 for all subscales, and 0.70 for seven out of 10 subscales (cf. Hair et al., 2010, p. 127).

Within the concept of dimensions of epistemic beliefs (Study II), it needs to be asked: why was the dimension of justification for knowing, originally suggested by Hofer & Pintrich (1997), omitted? The main reason was that this dimension was not included in any of the previous instruments (Table 1, p. 31) that I used as reference for constructing the instrument in Study II. A contributing reason was that, although justification had been introduced in the ISEQ instrument by Bråten et al. (2005), I had missed their study when searching background literature. On the other hand, in inventories that have been published in later studies, Ferguson et al. (2013, the Justification For Knowing Questionnaire, JFK-Q) and Bråten et al. (2019, the Internet-Specific Epistemic Justification Inventory, ISEJ) suggest that justification for knowing itself should be seen as a three-dimensional construct containing 1) justification by authority, 2) justification by multiple sources, and 3) personal justification. Comparing the ISEQ with the three ISEJ subdimensions shows that ISEQ actually covered only the latter two sub-dimensions. In retrospect, capturing original dimensions while at the same time introducing and testing novel dimensions was a rather broad task, and including justification would possibly have made the task too complicated to manage. In further retrospect, operationalising justification for knowing would have required framing the statements in contextual elements (see Section 6.3). To conclude, the choice of omitting justification for knowing as well as omitting contextual elements from these studies can be seen as a limitation, but also as a strength since this choice has probably contributed to keeping complexity on a manageable level.

The empirical approach to investigate epistemic beliefs has both strengths and limitations. As the studies in this thesis show, the concept and specifically the self-

report approach, although criticised (e.g., Gaete et al., 2018), is usable especially when trying to apply the concept into new areas or when trying to supplement the concept with new dimensions. At the same time, the studies illustrate the sample-dependency of exploratory factor analysis and the problems with replicating the analyses across different samples. Further, when data is collected using self-report questionnaires, there is always a degree of uncertainty about the extent to which the respondents have understood the statements as intended and responded seriously and honestly. On this point it is reasonable to assume that offering two non-substantial response options (see Section 4.4.2) contributed to fewer dishonest and biased responses (cf. Waters et al., 2022). The results further suggest that, when exploratory factor analysis replication turns out difficult, manually composed subscales is a plausible option. Respecting the suggested factor structure and sufficient internal consistencies are, of course, prerequisites for applying this option.

Finally, it may be noted that the data for this thesis were collected in 2011-2012, and therefore, the limited possibility to draw conclusions with relevance for phenomena in the current ICT and media environment can be regarded as a shortcoming. However, since the aim of the thesis was not to produce generalisable results but rather, on one hand, to explore the extendibility of epistemic dimensions, and on the other, to explore possible associations between ICT practices, internet reliance, and views of knowledge, the topicality of research data was of secondary importance. The analysis results contribute with several theoretical, methodological, and practical implications as described in Sections 6.2, 6.3 and 6.4.

6.6 Validity and reliability

The original studies were based on data stemming from the same total data set but on different subsamples and data subsets (see Figure 4, p. 59). Therefore, the discussions regarding validity and reliability issues differ somewhat between the studies.

The data used in Study I were based on two external instruments, the ICT Driving License (ICTDL, see Section 4.3.1) and the modified Students' Experience with Technology Questionnaire (SETQ, Gray et al., 2009; Kennedy et al., 2008). The validity of the ICTDL and the challenges of validating ICT skills tests in general are discussed in Study I. Unfortunately, the SETQ was never validated. However, at the time of the study and still today, the technological development is fast. Therefore, it is important to keep in mind that an instrument used one year for measuring ICT

skills (ICTDL) or ICT practices and experiences with technology (SETQ) will probably already be outdated the next year. Expecting such an instrument to be validated is thus almost in vain; the instrument is either current but unvalidated or validated but outdated. Still, the subscale scores based on the SETQ items showed good internal consistency and discriminant power, which indicates an acceptable construct and content validity considering the purpose of the study.

The data used in Study II were collected using an instrument (Section 4.3.2) that was partly inspired by previous epistemic beliefs inventories, and partly by literature describing the information behaviour of the young generation. Due to replicability issues, validated instruments were not available (cf. Schraw, 2013). Considering later discussions about conceptualising epistemic beliefs as general or context-specific (see Section 6.3), the lack of validated instruments is not surprising. The suggested EFA model showed good or reasonable fit indices and behaved in a consistent manner during internal replication and can therefore be regarded as holding initial construct and content validity, without claiming generalisability (which was never the aim of the study). For a detailed validity discussion regarding the instrument, please see Sections 5.1-5.2 in Study II.

In Study III, the subscale scores describing ICT practices were already available from Study I. For the dimensions of epistemic beliefs and internet reliance, the subscale scores were computed separately, partly based on the factor structure suggested in Study II. All the subscale scores showed good internal consistency (Study III, Tables 2, 3 and 4), which indicates acceptable construct and content validity considering the purpose of the study.

6.7 Conclusions and future research

As noted earlier (Sections 5.3 and 6.1), the results did not indicate any association between ICT practices and either internet reliance or epistemic beliefs, probably due to the fact that measuring ICT practices focused mainly on technology-based activities and did not consider information-oriented practices specifically. This may be traced back to the fact that the questionnaire used to collect data regarding ICT practices was based on the SETQ (Gray et al., 2009; Kennedy et al., 2008). The SETQ reflected the contemporary approach to ICT; that is, focus was on access to technology and purposes for using technology, whereas information retrieval and information literacy were not emphasised. In an attempt to update the instrument, the original SETQ was extended with a new section on internet use, which aimed at

capturing the many different purposes for using the internet. In the extended questionnaire, information retrieval was, however, only one purpose among others. The section regarding the use of mobile phones contained one single item connected to information search but also in this case, the phrasing was very non-specific ("... using a mobile phone to browse the web").

Thus, in the future, the associations between ICT practices, internet reliance and epistemic beliefs should be measured more broadly. Besides general ICT practices, measuring should include such specific ICT practices that can be expected to influence internet reliance and epistemic beliefs, that is, knowledge- and information-(searching-) oriented activities. Information searching usually results in the user finding information, which is about testimonies stemming from some source, that is, testimonies that should be assessed and justified (or discarded). Therefore, justification for knowing should be included but this will, in turn, require framing the statements in one or more contextual elements, while also acknowledging the testimonial aspect; that is, who is uttering the information that the hearer is supposed to assess and justify.

In order to meet the demand that research around the dimensions of epistemic beliefs should involve contextual elements and also include justification for knowing, one avenue for future research would be to combine the original EQ dimensions (Schommer, 1990, 1993, 1998) with the validated Internet-Specific Epistemic Justification Inventory (ISEJ, Bråten et al., 2019). Ways of framing the measurement into an appropriate context has recently been suggested by Ståhl (in press). This avenue for research is in line with the perspectives for future research suggested by Zlatkin-Troitschanskaia et al. (2021) as a conclusion of their review study. Further, it applies the suggestion by Chinn et al. (2011) about exploring epistemic beliefs on a more fine-grained level.

Sundin et al. (2017) suggest that one way of understanding users' reliance on search engines is to relate this reliance to how we trust human authorities. In Alasuutari's (2018) conceptualisation, the power of an actor[14] can rely on various types of authority. If users believe that search engines are "… widely known, trusted and respected …", then users may regard search engines as having what Alasuutari calls charismatic authority. Recent research (Cotter, 2021) maintains that algorithmic authority is a central component also within social media platforms, where restricted access to information about the algorithms has enabled platforms to achieve a position, which Cotter describes as epistemic authority.

[14] Alasuutari does not specify that the actor would be human, nor does he exclude non-human actors.

Concerning information management and knowledge construction on the personal level, the future appears more complicated than ever. Rather recently, the chatbot ChatGPT (OpenAI, 2023) was introduced for open access. Based on a question from the user, ChatGPT is constructed to compilate and generate an answer based on existing texts on the internet. ChatGPT is linguistically "trained" and supposed to learn from feedback provided by the users. Consequently, the answers provided by ChatGPT will continuously improve and emulate texts produced by humans. If the source texts contain mis-/disinformation, it will accumulate. Although the future may look different, these features pose several questions: How will users be able to decide if the text they are reading originates from a human writer or from a bot? If the source of testimony remains unknown, how will users be able to decide which justification strategy to use for assessing and justifying these testimonies? Questions like these will place increasing demands on providing equal opportunities for all on a global level to develop their information literacies and epistemic competence.

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APPENDICES

Subject: welcome to tell us about You, ICT and media

Dear Arcada student!

During week 35 all new Arcada students are invited to participate in a survey called "Me, ICT and media" prior to the ICT Driving License level tests. The survey is part of a study regarding our students' use of ICT (Information and Communications Technologies) and media, and regarding our students' expectations on ICT in their studies. The study is part of the Arcada project "Active learning for the net generation".

Collected data will be processed anonymously. By participating in the survey you give Arcada the permission to use survey data for the purpose above and as described in the Research Data File Description below. Should you choose to withdraw your permission you can do it by contacting the researcher on Monday 10.9.2012 at the latest. After that your answers cannot be located among the anonymous data.

Your participation is voluntary, but since the study is about developing Arcada we strongly advice you to participate!

To the survey: %URL%&FL=1 [1]

Thank you for contributing to the development of Arcada!

Tore Ståhl
Development manager, Arcada
Research Data File Description https://arcada.itslearning.com/tore/active/

Subject: welcome to tell us about your view on knowledge

Dear Arcada student!

The survey “Me and my knowledge" is the second one of the surveys to which we are inviting our new students in the Autumn of 2012. This survey is also part of the Arcada research project "Active learning for the net generation" regarding how our students' relate to ICT, media, knowledge and learning.

Collected data will be processed anonymously. By participating in the survey you give Arcada the permission to use survey data for the purpose above and as described in the Research Data File Description below. Should you choose to withdraw your permission you can do it by contacting the researcher on September the 10th 2012 at the latest. After that your answers cannot be located among the anonymous data.

Your participation is voluntary, but since the study is about developing Arcada we strongly advice you to participate!

To the survey: %URL%&FL=1 [1]

Thank you for contributing to the development of Arcada!

Tore Ståhl
Development manager, Arcada
Research Data File Description https://arcada.itslearning.com/tore/active/

[1] Code for generating the unique URL to each respondent’s personal survey form.

DESCRIPTION OF THE SCIENTIFIC RESEARCH DATA FILE
Personal Data Act (523/1999) Sections 10 and 14
22.8.2011

1a Research Data File controller	Name Arcada – Nylands svenska yrkeshögskola Rector Henrik Wolff	
	Contact Jan-Magnus Janssons plats 1, 00550 Helsingfors	
1b Research partners	Arcada is conducting this research without cooperating partners	
1c Person or group in charge for the research	Head of Research, PhD Jukka Surakka, Arcada	
1d Research is conducted by (data administrator)	Development manager in pedagogy, M.Ed. Tore Ståhl, Arcada	
2 Contact person on research data file issues	Name Development manager in pedagogy, M.Ed. Tore Ståhl	
	Contact Jan-Magnus Janssons plats 1, 00550 Helsingfors tel. 0207 699 504, tore.stahl(at)arcada.fi	
3 Research Data File	Name of Data File The research will use three Data Files: 1. Me, ICT and media 2. Me and my knowledge 3. Data from the initial ICT Driving License level tests	
	☒ One-off research project (this research can later be part of a follow-up research)	☐ Follow-up research
	Duration Data collection in the autumn of 2011, possibly also in the autumn of 2012, analysis during 2011-2013.	
4 Objectives of research	The purpose of the data files is to collect data describing the students' ICT skills, ICT and media habits and their personal view of knowledge. Collected data will be used in the Arcada research project "Active learning for the net generation". The project aims at deepening our knowledge about our students in order to create the prerequisites for developing our education into more active and student centred learning. Data processing and administration is supported by Arcada's obligation to continuously follow up and evaluate the education as prescribed by law. The data administrator will process the data with the aim to find answers to the questions put in the research project. No reports that might reveal the identities of the respondents will be generated. The results are reported in scientific publications and only in the form of trends by groups and with respect for common research ethics.	
5 Contents of the Data File	The three files (section 3) will contain information about: • results from the initial (compulsory) ICT Driving License level tests, • respondents' responses to the questions in the two surveys. In all the three files the respondents' e-mail address/user name will be included as identification data. Also year of birth, gender, nationality and degree	

	programme will be used as recorded in Arcada's student registry. Survey data will initially be collected in two separate files that will later be merged into one file together with the ICT Driving License level test results. The mail addresses will be used to send the invitations to fill in the web based questionnaires, but also as identification data to enable the file merge. After the file merge e-mail addresses/user names will be removed from all records, and thus the final data file will contain only anonymous data.
6 Composition of research data	Data collection will be performed using web based questionnaires among students starting their studies at Arcada in the autumn of 2011. Data collection may possibly be repeated in the autumn of 2012 among the students starting their studies at that time. Participating in the surveys is voluntary, but strongly recommended by Arcada. Data processing and administration is supported by Arcada's obligation to continuously follow up and evaluate the education as prescribed by law.
7 Sharing research data	No personal data are shared
8 Sharing research data outside EU or EEA territory	No personal data are shared outside EU or EEA territory
9 The principles of data file protection	☐ Data is confidential
	Manual data: All data are collected and processed electronically
	Electronically processed personal data: ☒ username ☐ access control ☐ password ☐ user surveillance ☒other, please specify: see sect. 5 During data collection survey data files are stored on database servers maintained by Analystica Ltd, and after that on Arcada's database servers. In both cases access requires authorisation and authentication using a username and password accessible only to the administrator (sect. 1d).
	☒ Identification data are removed prior to analysis ☐ Data are analysed by means of identification data on the following grounds:
10 Research Data File; Destruction and archiving	☐ The Research Data File will be destroyed ☒ The Research Data File will be archived ☒ without identification data ☐ including identification data Location: The Research Data File will be archived at Arcada and possibly also in Finnish Social Science Data Archive http://www.fsd.uta.fi/english/index.html

Participation in research

Dear student!

Arcada is continuously striving to develop and improve our education. As part of this we have a research project where we will explore how our students use computers, Internet, mobile phones and media, and how they regard knowledge.

We are offering you the opportunity to participate in this research – and to **contribute to improving your own studies** – by participating in two surveys:

1. Me, ICT and media
2. Me and my knowledge

You will receive invitations by email. Please observe:

- **Arcada recommends you to participate** in both surveys.
- Participating is **voluntary**.
- The data collected will contain identification data, so that data from the two surveys and ICT Level Test data can be merged.
- After merging all identification data will be removed, thus resulting in a set of **anonymous** data.
- Analysis and reporting will be done on group level only (no individual data are reported).
- The research is part of the focus area "Active learning" in Arcada's strategy for the period 2010-2012. The research is based on section 9 in the Universities of Applied Sciences Act 9.5.2003/351, stating that each University of Applied Sciences has to "… be responsible for the quality and the continuous development of … the education offered".

By participating in the surveys you give your permission for using the data for the purposes described above and in the Description of the Research Data File https://arcada.itslearning.com/tore/active/. Should you choose to withdraw your permission you can do it by contacting the researcher on September the 10th 2012 at the latest. After that your answers cannot be located among the anonymous data.

The research is conducted by Tore Ståhl (M.Ed.) and it has been approved by Arcada's Board on Ethics.

Arcada in August 2012

Tore Ståhl
Development manager, M.Ed., Arcada, tore.stahl@arcada.fi
Doctorate, Tampereen yliopisto, tore.stahl@uta.fi

Topic	Topic heading, items	type
Socio-economic ba	**Background information**	
Socio-economic ba	What did you mainly do during the year before starting your studies at Arcada?	mc
Socio-economic ba	Where did you mainly live during the last year?	mc
Socio-economic ba	I grew up with mainly...	mc
Socio-economic ba	The educational level of my first/only parent:	mc
Socio-economic ba	The educational level of my second parent:	mc
Socio-economic ba	Which upper secondary school did you attend?	txt
Technology access	**Please indicate your level of access to the following types of devices and services during the last year**	
Technology access	Computer (desktop, portable or laptop)	loa
Technology access	surf pad / tablet pc / netbook /iPad	loa
Technology access	eBook Reader (e.g. Kindle, Nuut, BeBook, Cybook)	loa
Technology access	Web cam	loa
Technology access	A mobile phone of some kind	loa
Technology access	Dedicated video game console (e.g. Xbox, Playstation)	loa
Technology access	My computer is a ...	mc
Technology access	How is your computer connected to the Internet?	mc
Technology access	My mobile phone has an MP3 player	y/n
Technology access	My mobile phone has a camera	y/n
Technology access	My mobile phone has video capability (3G)	y/n
Technology access	My mobile phone is connected to the internet	y/n
Social media	**Social media**	
Social media	I have at least sometimes used: (delicious.com, Facebook, Habbo Hotel, LinkedIn, MySpace, Second Life, Twitter, World of Warcraft)	ma
Social media	Why have you chosen not to use any social media or virtual worlds? (open ended question)	txt
Technology history	**Try to recall some important event, e.g. when did you finish primary school? Use that to help recalling the years asked for in the following questions**	
Technology history	Since what YEAR have you had the opportunity to use a computer at home?	n
Technology history	Since what YEAR have you been using a mobile phone of your own?	n
Technology history	What year did you start accessing Internet from your home computer?	n
Technology history	What YEAR did you purchase your current (latest) desktop or other computer?	n
Technology history	What YEAR did you buy your current mobile phone?	n
Technology history	Who chose the model of your current computer / laptop?	mc
Technology history	Who chose the model of your current mobile phone?	mc
Usage and skills 1	**Below is a list of different ways of using computers. Please indicate: 1. How OFTEN, on average, you have used computers in each way over the past year. 2. How SKILLED you are at using computers? If you have never used a computer for the described purpose, please tick NU (Not Used)**	
Usage and skills 1	write and edit texts ...	f/sk
Usage and skills 1	use a spreadsheet software ...	f/sk
Usage and skills 1	create presentations ...	f/sk

Topic	Topic heading, items	type
Usage and skills 1	create or edit digital images ...	f/sk
Usage and skills 1	manage or edit digital photos ...	f/sk
Usage and skills 1	play games on computer ...	f/sk
Usage and skills 1	play games on games console ...	f/sk
Usage and skills 1	manage email using mail client ...	f/sk
Usage and skills 2	**Below is a list of different ways of using the Internet. Please indicate: 1. How OFTEN, ... 2. How SKILLED ...**	
Usage and skills 2	use the web to access a school portal or LMS ...	f/sk
Usage and skills 2	use a webmail service (e.g. Hotmail, Gmail) ...	f/sk
Usage and skills 2	use the web to look up reference information for studies ...	f/sk
Usage and skills 2	use the web to look up current information ...	f/sk
Usage and skills 2	use the web to look up practical information ...	f/sk
Usage and skills 2	use the web for desktop conferencing ...	f/sk
Usage and skills 2	use internet for instant messaging, chat ...	f/sk
Usage and skills 2	use the web for phoning, e.g. Skype ...	f/sk
Usage and skills 2	use the web to share photographs ...	f/sk
Usage and skills 2	use the web to keep my own blog or vlog ...	f/sk
Usage and skills 2	use the web to read other people's blogs or vlogs ...	f/sk
Usage and skills 2	use the web to comment on blogs or vlogs ...	f/sk
Usage and skills 2	use Internet shopping ...	f/sk
Usage and skills 2	use the web to buy services e.g. tickets ...	f/sk
Usage and skills 2	use the web for banking services ...	f/sk
Usage and skills 2	use the web to buy/sell things with private persons directly or by auction ...	f/sk
Usage and skills 2	use the web to download MP3 files ...	f/sk
Usage and skills 2	use the web to upload and share MP3 ...	f/sk
Usage and skills 2	use the web for streamed music ...	f/sk
Usage and skills 2	use web/LAN to play networked games ...	f/sk
Usage and skills 3	**Below is a list of different ways in which mobile phones can be used. Please indicate: 1. How OFTEN ... 2. How SKILLED ...**	
Usage and skills 3	use a mobile phone to call people ...	f/sk
Usage and skills 3	use a mobile phone for SMSing ...	f/sk
Usage and skills 3	use a mobile phone to take digital photos or movies ...	f/sk
Usage and skills 3	use a mobile phone to send pictures or movies to other people ...	f/sk
Usage and skills 3	use a mobile phone for video calls ...	f/sk
Usage and skills 3	use a mobile phone as an MP3 player ...	f/sk
Usage and skills 3	use a mobile phone as a personal organiser ...	f/sk
Usage and skills 3	use a mobile phone to send and receive email ...	f/sk
Usage and skills 3	use a mobile phone to browse the web ...	f/sk
Usage and skills 3	use a mobile phone to receive RSS ...	f/sk
Usage and skills 3	use a mobile phone to play games ...	f/sk
Expectations	**Please rate how useful each of the following services are or would be in your studies (regardless of whether you have used them earlier or not)**	
Expectations	I wish I could access audio/video recordings of lectures I did not attend	vas
Expectations	I wish I could access audio/video recordings to review the content of lectures I did attend	vas

Topic	Topic heading, items	type
Expectations	I wish I could use the web to access University services	vas
Expectations	I wish I could use my mobile phone to access University services	vas
Expectations	I wish I could use social media to communicate within a course	vas
Expectations	I wish I could use virtual worlds to communicate within a course	vas
Expectations	I wish the university would provide one single online learning environment for all my study issues	vas
Expectations	I wish I could use the university's online learning environment separate from my social media	vas
Expectations	I wish I could use webconferencing to communicate within a course	vas
Expectations	I wish I could receive alerts about courses as SMS	vas
Expectations	I wish I could receive alerts about courses via RSS	vas
Expectations	I wish I could create a wiki together with other students as part of the course requirements	vas
Media practices	**About following news in various media**	
Media practices	I follow the news in newspaper(s)	f
Media practices	I follow the news on the TV	f
Media practices	I follow the news on the radio	f
Media practices	I follow the news on some newspapers' web sites	f
Media practices	I follow the news on some TV channels' web sites	f
Media practices	I follow the news using RSS feeds	f
Media practices	I use an app on my mobile phone to follow the news	f
Reading habits	**About reading habits and preferences**	
Reading habits	I read novels, fiction etc. (school books not counted)	f
Reading habits	I'm quite ok with reading long Internet texts (news, articles etc.) on the screen	y/n
Reading habits	I prefer reading a long Internet text printed on paper	y/n
Reading habits	How many pages is an Internet text that you would most probably print out on paper instead of reading it on the screen	n
Table footnotes		
	Scales: f=use frequency, f/sk=use frequency and skills, loa= level of access, ma=multiple answer, mc=multiple choice, n=numeric, txt=text, vas=Visual Analogue Scale, y/n=yes/no	
	For items in the Usage and skills category data was collected using 7-point anchored scales for use frequency and skill level, respectively.	
	Use frequency scale options: Once-twice a year (7)/ Every few months/ Once-twice a month/ Once a week/ Several times a week/ Every day/ Several times a day/ Never used (1)	
	Skill scale options: poor (1) .. excellent (7)	

Dimension / item name	Item label	Final dimension
Certainty of knowledge		
k03_8	A true fact today will also be a true fact tomorrow.	Certainty of knowledge
k04_2F13	There are scientific facts that will never change	Certainty of knowledge
k06_7	I like teachers who present several different views and let me decide which is best.	-
k11_10	Truth can mean different things to different people.	-
k13_2F44	There are truths that will always stand	-
k14_2F49	Scientific research shows that there is one correct answer to most problems	-
Connectivist approach to learning		
k04_3	When I need to learn about something new, I often ask several friends about their opinion	Learning by dialogue
k04_6	The more knowledgeable people I know, the more knowledge I have myself	-
k05_6	I feel that I learn more when I meet someone new who knows a lot about a field	-
k06_5	I build knowledge by developing and maintaining my networks and connections	-
k07_6	To learn more I need to keep contact with the people I know	-
k08_3	Knowledge may reside also in non-human things like mobile phones, iPods, web services	-
k08_5	For me, learning is about forming a network of connected information sources	-
Constructivist approach to learning		
k05_4	My knowledge is an individual matter and it cannot be created together with others	-
k06_1	The knowledge I already have is like hooks, where I can hang up new pieces of knowledge	-
k07_2	Learning is about recognizing patterns and connections between concepts and phenomena	Constructivist approach to learning
k07_4	Knowing is not an end state, but an on-going process	Constructivist approach to learning
k08_6	In order to know more it's important for me to see the connection between things I already know and new things I learn about	-
k10_3	It's important to keep track of changes in what I know in order to keep my knowledge up-to-date	-
k13_5	If I re-read a textbook chapter, I get a lot more out of it the second time	-
Internet reliance		
k07_7	Wikipedia is reliable since it is written by many people with different viewpoints	-
k10_4	Wikipedia is reliable since it is up-to-date	-
k12_6	I learn things quicker from Internet pages than from books	Internet reliance
k13_6	Internet sources usually provide me with a clearer picture of subjects than do books	Internet reliance
k14_5	I can get almost all the information I need to know about a subject from one or two Internet sources	Internet reliance
Just-in-time learners		
k04_1	Learning is about deciding what I need to memorise and what I can look up somewhere later	-
k06_6	If I don't know something it doesn't bother me as long as I know how to learn about it	-
k08_1	Knowing where to find knowledge is more important than the piece of knowledge itself	-
k10_5	Choosing what to learn is the starting point for my learning	-
k10_6	Knowledge is not about knowing the answers, but knowing how and where to find the answers	-

Dimension / item name	Item label	Final dimension
Learning ability		
k09_5F31	Each person needs to learn for her-/himself how she/he learns	Learning ability
k11_1F33	A focussed use of learning techniques will lead to better results	Learning ability
k12_9	Some people are born good learners, others never learn how to learn.	-
k13_4F47	It is possible to learn how to learn	Learning ability
Omniscient authority		
k03_3F09	I can believe almost everything I read as part of my studies	-
k04_4F04	All experts within a field have the same understanding regarding the basic issues of that field	Certainty of knowledge
k05_1F15	All teachers will probably arrive at the same answers regarding issues within their field	-
k09_3F29	I have to accept the answers from a teacher as true	Omniscient authority
k11_7	Forming my own ideas about a topic is more important than learning what the textbooks say.	-
k12_5F42	Teachers are almost always right	Omniscient authority
k14_7	I seldom or never question authorities	Omniscient authority
Reflective nature of learning		
k08_4F27	When I learn new things it often causes me to question my earlier knowledge	-
k09_1F28	When I learn new things I often see my previous knowledge in a new light	Constructivist approach to learning
k14_1F48	After thorough consideration I can often see a problem with new eyes	Constructivist approach to learning
k14_4F51	New experiences cause me to view knowledge in another way	Constructivist approach to learning
Structure of knowledge		
k05_7	To me, studying means getting the big ideas from the text rather than details.	-
k06_8	To be a good student I try to memorize lots of facts.	-
k07_8	When I study, I mostly concentrate on specific facts.	-
k09_7	I like teachers who organize their lectures carefully and then stick to their plan.	-
k10_7	It bothers me when a teacher does not say clearly what I am supposed to know in an examination.	Structure of knowledge
k11_8	It bothers me when teachers do not tell me the answers to complicated problems.	Structure of knowledge
k11_9	I prefer topics where most problems have only one right answer.	Structure of knowledge
k12_7	I try my best to combine information across chapters or even across classes.	-
k12_8	Teachers should focus on simple facts instead of complicated theories.	-
k13_7	I find it annoying to listen to teachers who cannot make their mind up about what they believe.	Structure of knowledge
Valuing diversity		
k03_5	I create knowledge by interacting with others	Learning by dialogue
k03_7	I like discussing with people who have varying opinions	Learning by dialogue
k04_5	I find it interesting to think about issues that people cannot agree on	-
k05_2	The value of knowledge lies in its ability to explain an issue from multiple perspectives	Constructivist approach to learning
k09_2	Knowledge is about seeing a matter from diverse perspectives, building up the whole	Constructivist approach to learning

PUBLICATIONS

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Publication II Ståhl, T. (2019). Epistemic Beliefs and Googling. *Frontline Learning Research*, 7(3), 27-63. https://doi.org/10.14786/flr.v7i3.417

Publication III Ståhl, T., Sormunen, E., & Mäkinen, M. (2021). Epistemic beliefs and internet reliance – is algorithmic authority part of the picture? *Information and Learning Sciences*, 122(11/12), 726–748. https://doi.org/10.1108/ILS-01-2021-0004

PUBLICATION I

How ICT savvy are Digital Natives actually?

Ståhl, Tore

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How ICT savvy are Digital Natives actually?

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ABSTRACT

The purpose of this article is to explore how habits of using Information and Communications Technologies (hereafter ICT) and actual ICT skills relate to what has been called Digital Natives.

The present study explores Digital Native-like people and other groups among two cohorts of students in their first year of university, contributing to the overall picture of Digital Natives as part of the young generation. The study combines survey data describing ICT and media use with test data describing performance-based ICT skills.

THE DIGITAL NATIVES DEBATE

During the first decade of this millennium, the growing generation was in the focus of an extensive debate in terms of a so-called Net Generation (Tapscott, 1998), Millennials (Howe & Strauss, 2000) and Digital Natives (Prensky, 2001a; Prensky, 2001b). Jones et al. (2010) provide a comprehensive overview of the terms used.

The common denominator for many advocates of a digital generation was that they attributed the members of the young generation with different characteristics that they maintained were a direct outcome of technology use, and they generalized the suggested characteristics to apply to the whole age cohort. Almost concurrently with this debate, George Siemens (2005) presented his learning theory for the digital age, suggesting that learning will be different. To some extent, the ways of acting and learning suggested by Siemens resemble the characteristics attributed to the Digital Natives.

For several years, the public and the academic rhetoric accepted the thought of a whole generation being homogeneous regarding both ICT skills and ways of using and relating to ICT. Eventually, critical voices (e.g. Best & Kellner, 2003; Lee, 2005) appeared to challenge the over-generalizing rhetoric, now suggesting that the Net Generation may be even more heterogeneous than any previous generation. Still, Best and Kellner (2003) pointed out that this generation is indeed the first one to grow up surrounded by the internet, multimedia and new media. It might be added that the Net Generation also lacks a personal experience of the time before the internet, search engines and mobile phones, not to mention smartphones.

In the Digital Natives rhetoric, the simplified picture of homogeneous generations has been used as an overriding explanatory factor. However, drawing upon Mannheim (in Buckingham, 2006, p. 2), the Digital Natives will initially have had 'similar life chances', but by the time they enter higher education they will have had different experiences and they will have made different things out of their life chances. Thus, a heterogeneity seems inevitable.

Digital Natives characteristics

The intensive debate during the last decade did not produce a clear definition for Digital Natives. Different characteristics were suggested, and these will serve to describe the Digital Natives concept.

Prensky (2001a; 2001b) maintained that Digital Natives are used to receiving information fast, they like to parallel process and multi-task, prefer random access rather than structured information, function best when networked and prefer games to "serious" work.

Digital Natives were described as 'just-in-time learners', knowing where to find information once they need it. Their process of thinking relies on social network navigation (Anderson & Balsamo, 2008, p. 244). They are committed to a culture of sharing, for example pictures, status updates, likes, and so on. (cf. Horrigan, 2007; Kennedy, Judd, Dalgarno, & Waycott, 2010). They are ICT savvy, and they are heavy users of a multitude of technical devices (e.g. Tapscott, 1998, p. 40, 99; Prensky, 2001a; Horrigan, 2007).

The characteristics were about use preferences and habits, but also about ICT skills, connected by the assumption that heavy use of devices and ICT skills nourish each other. Throughout the debate, the characteristics were presented in a generalizing manner, suggesting that all members of the young generation are ICT savvy and constantly connected, but the question needs to be asked whether they are.

Digital Natives, generations and ICT

Several research projects have explored and questioned the existence of a homogeneous Net Generation with a general net savviness, and the results more or less put an end to the oversimplification and generalization (see Helsper & Eynon, 2010; Jones & Hosein, 2010; Jones et al., 2010; Lai & Hong, 2015; Litt, 2013; Thompson, 2013 for informative overviews). Briefly, the main findings of the aforementioned studies, and those studies they are referring to, are that the Net Generation is not homogeneous, and all young people do not report using ICT very broadly or feel that they master ICT so well. The gap left by previous research concerns: the performance-based ICT skills (as opposed to self-reported) within the generation; to what extent Digital Native-like groups can be identified; and how ICT skills are distributed within and across different groups.

The following sections reproduce in brief some studies that are of special interest for the present study.

ICT use patterns

Different groups describing the heterogeneity within the young generation have been identified by surveying use habits, for example Kennedy et al. (2010) and Jones and Hosein (2010). Van den Beemt, Akkerman, and Simons (2011) surveyed actual use and opinions among 2,138 Dutch users, and presented a typology based on use patterns.

North, Snyder and Bulfin (2008), building on Bourdieu's concepts of 'habitus' and 'taste', argue that the digital taste of young people is influenced by markers of class, which is something more than merely socio-economic status. Robinson (2009) noticed that respondents having good and high-autonomy access to ICT resources induced a more playful and exploratory stance towards online information seeking, an approach that Robinson labels 'playing seriously'.

Helsper and Eynon (2010) concluded that it is not meaningful to define natives and immigrants as a dichotomy, but rather as characteristics on a continuum, and most importantly, being an immigrant is not a final state.

ICT access, skills and a digital divide

Previous studies agree that on average, young individuals use ICT intensively but skills are prevailingly measured using self-report instruments. Kvavik and Caruso (2005) reported that leisure time skills did not translate into the kind of digital literacy required in higher education, and in general, the results from several studies refute the assumption that the whole generation would be very skilled in ICT (e.g. Kennedy, Judd, Churchward, Gray, & Krause, 2008; Kennedy et al., 2010; van Deursen & van Dijk, 2009; Helsper & Eynon, 2010; Bullen, Morgan, & Qayyum, 2011; van den Beemt et al., 2011; Kirschner & van Merriënboer, 2013).

Van Dijk (2008, p. 290) presents a recursive and cumulative model of access to digital technologies containing four types of access, marking the necessary steps to make use of digital technology. *Motivation* to use a technology of some kind is the first step, with some resemblance to the digital habitus and taste described by North, Snyder, and Bulfin (2008). The next three steps express that, provided sufficient (2) *material, physical and temporal access* to ICT resources, the individual will be able to (3) *develop* her skills, which in turn will (4) *empower* her to use ICT resources for personal objectives. Lack of material access expresses the so-called primary level digital divide (cf. Büchi, Just, & Latzer, 2016). Lack of skills and usage are distinguished as secondary and tertiary levels of digital divide. Neither access nor divide are to be regarded as dichotomous, but rather as operating on continua.

Skill differences have been discussed in terms of a digital divide (Buckingham, 2006, p. 9; van Dijk, 2008, p. 290). Büchi, Just and Latzer (2016) present a five-country study regarding differences in Internet use and an overview of studies confirming the persisting digital divide both between and within countries. Their own study, surveying five high-penetration English-speaking countries, showed that the digital divide has shifted from lack of access (first-level) to lack of use, that is, second or third-level digital divides.

Descriptions of performance-based ICT skills are scarce and have been called for (cf. Litt, 2013; Huggins, Ritzhaupt, & Dawson, 2014). Van Deursen and van Dijk (2009) measured what they call *Operational, Formal, Information and Strategic skills*, using performance-based tests. The so-called Net Generation scored relatively high in operational and formal tasks, but not significantly better in information and strategic skills compared to older participants. Van Deursen and van Dijk (2009), and van Deursen et al. (2012), supplemented performance-based tests with observations, and conclude that observation can improve reliability but is too time-consuming to be used in large-scale settings (such as testing cohorts of university first years).

Gui and Argentin (2011) measured theoretical, operational and evaluation skills among Italian teenagers, and report good performance in operational skills, but poor performance in evaluation skills, although with some doubt regarding reliability.

Aesaert and van Braak (2015) report performance-based testing among sixth-graders using a walled (closed) test environment, which highlights a specific challenge: reliability of the tests can be improved by creating standardized, simulation-based tasks in a closed environment, but on the cost of authenticity. Creating similar tasks in an open environment appraises authenticity, but reduces reliability due to the constantly changing ICT environment, which in turn requires effort for updating the tasks to correspond to contemporaneity.

Research questions

Out of the studies cited in the previous sections, Horrigan (2007), Jones and Hosein (2010), and van den Beemt, Akkerman, and Simons (2011) identified groups based on use patterns, but did not measure ICT skills. Then again, van Deursen and van Dijk (2009) and Aesaert and van Braak (2015) measured performance-based skills, but not in relation to use patterns. There is an apparent research gap regarding performance-based (as opposed to self-reported) ICT skills and how skills relate to Digital Nativeness. Ultimately, this information will contribute to clarifying questions around digital divides.

Assuming the young generation is heterogeneous and considering the call for descriptions of the generational heterogeneity (cf. Kennedy et al., 2010; Litt, 2013; van den Beemt et al., 2011), the present research will explore what this heterogeneity looks like in terms of ICT use patterns and performance-based ICT skills. The research is guided by the following research questions:

1. What groups can be identified based on the users' ICT and media practices?
2. What are the actual ICT skills among the young generation?
3. To which extent can members of the young generation be regarded as Digital Natives or Native-like?

It needs to be stated that an elaboration of the topic of digital divide is beyond the limits of this study, and the same applies for the vast discussion regarding digital literacies. Instead, this study focuses on the distribution of performance-based ICT skills on the levels of operational, formal, information and strategic skills (cf. van Deursen & van Dijk, 2009).

METHOD

In order not to blur skills and use practices, the present study set out to first identify groups based on use practice variables not connected to skills, and thereafter to explore performance-based ICT skills across these groups.

Participants and data sources

Data collection aimed at taking a snapshot of the students just entering the university with the ICT skills they carry along. Research data was collected during the introductory week among all first years entering some of the fourteen bachelor degree programmes (Table 1) at Arcada University of applied Sciences in Finland in the autumn of 2011 and 2012. The university working language is Swedish, and it recruits students mainly among the Swedish-speaking minority population, but also attracts international students. This presentation draws upon data from a survey and the ICT Driving Licence level tests.[1]

ICT, media and me

The objective of this survey was to collect data about the students' background regarding ICT and media use. The survey was based on the Australian SETQ questionnaire (Kennedy et al., 2008; Gray et al., 2009). The SETQ was modified to correspond to the local context and contemporary ICT (e.g. 3G mobile connectivity), and also extended, such that the survey included items describing background, use frequency, and perceived skills regarding common software, use habits, and purposes for using ICT resources, gadgets and digital news media.

The survey was administered online with items grouped around aforementioned topics and portioned over 36 pages. Use frequencies and skills were registered on an 8-point scale, ranging from 'Never used/poor' (1) over 'Once-twice a year' (2) up to 'Several times a day/excellent' (8) (Figure 1).

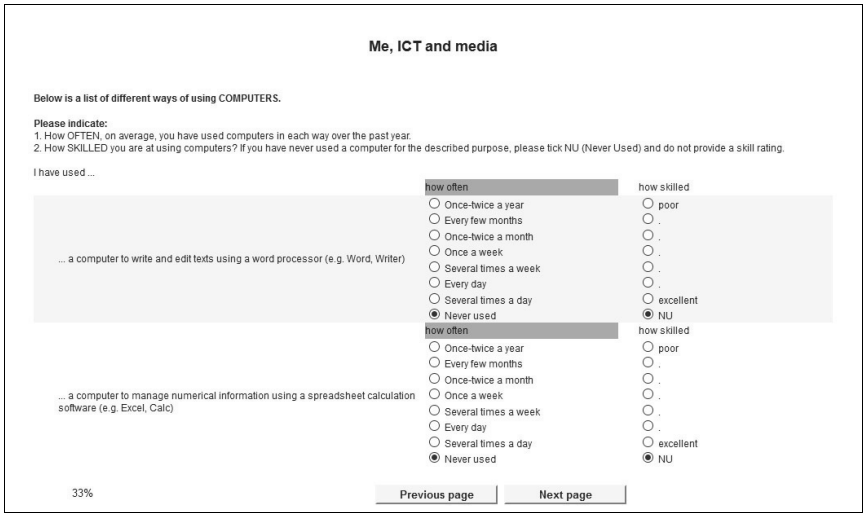

Figure 1. Sample screenshot illustrating a questionnaire page containing items regarding use frequency and perceived skill level.

1. Hereafter ICTDL.

The ICT Driving Licence

The ICTDL was developed at the University of Helsinki[2] and used across all its faculties since 2006, at Arcada University of applied Sciences since 2008. The ICTDL was a compulsory part of the Introduction to University Studies course, and the level tests were used for low-stakes assessment of performance-based, basic ICT skills. Based on level test scores, students chose an appropriate study path, that is, tuition or self-studies. The course was completed with an ICTDL examination test (grading passed/failed). The ICTDL level tests, study material and examination tests were published on the university's online learning environment. As opposed to Aesaert and van Braak (2015), all tests were performed in authentic online environments.

The level test modules cover basic ICT topics (cf. the ST^{2}L, Hohlfeld, Ritzhaupt, & Barron, 2010):

1. Basic use of computers, for example files, software and hardware, but also internet and e-mail.
2. The ICT services at the university (excluded from analyses).
3. Modifying and presenting data, that is, basic office tools.
4. Information seeking, library catalogues and reference databases.
5. Information security and privacy protection.

Level test scores for modules 1, 3, 4 and 5 were used for analyses. Module 2 scores were omitted, since they do not reflect ICT skills expected prior to entering university. Since the constantly expanding web and communication topics were included in module 1, it was more comprehensive than the other modules.

Van Deursen and van Dijk (2009) note that ICT skills tests seldom go beyond 'button knowledge' and operational skills, but on this point, the ICTDL had some strengths. Each of the five level tests contained four 1-point questions, measuring mainly operational and formal skills. Further, the tests contained two 3-point skill tasks, requiring both technical skills and higher-order competences (cf. Aesaert & van Braak, 2015). The ICTDL was innovative in most of the dimensions suggested by Parshall et al. (2002, cited in Hohlfeld et al., 2010; cf. Gui & Argentin, 2011). The time-limited tests utilized extensive randomizing functions (items, attachments, order). In order to enable automatic scoring and assessment of large student volumes, multiple choice (MCQ) or matching was used as response methods. Below are two sample items (somewhat shortened), illustrating module 1:

- 1p: You want to listen to a recorded lecture. To which port (see image) should you attach your headphones? [MCQ, image displaying a variety of plugs].
- 3p: Save the attached zip-file, containing files and folders, in your home directory. Sort all document files into the folder 'Documents', and all image files into the folder 'Pictures'. How much space do the picture folder files require? [MCQ, 11 options covering both kB and MB values].

2. https://www.helsinki.fi/en/ict-driving-licence

Data collection and research data

Data collection was organized in connection to the compulsory ICTDL Level Test sessions, scheduled for all new students during the first week of the semester (cf. Kennedy et al., 2008; Lai & Hong, 2015). For the purpose of informed consent, the students were introduced to the objectives of both survey and tests and informed (orally and in writing) that, although level tests were compulsory, the survey was voluntary. The students were introduced into the questionnaire and informed that support was provided if needed. Those who chose to participate first completed the survey 'Me, ICT, and media', and then the ICTDL level tests, so that the results in the level tests did not influence the students' self-assessment of their ICT skills (cf. van Deursen & van Dijk, 2009). Both the survey and the tests were administered online, and set up so that responses were stored as the respondent proceeded through the survey/test.

The questionnaires were distributed by individual e-mails containing a unique link to each respondent's questionnaire. Among the two cohorts, 916 students completed the survey and/or the test. After data collection, the data sets were merged and anonymized.

Table 1. Total sample and present subsample.

Science categories	**Total sample**			**Present study subsample**		
Degree programmes	**N**	**female %**	**portion**	**N**	**female %**	**portion**
Soft-applied science base	**267**	**85.4 %**	**29.1 %**	**190**	**91.6 %**	**26.6 %**
Nursing (dom+int)*)	150	84.0 %		95	91.6 %	
Occupational Therapy (dom)	35	94.3 %		33	97.0 %	
Social Services (dom)	82	84.1 %		62	88.7 %	
Mixed science base	**422**	**61.4 %**	**46.1 %**	**343**	**62.4 %**	**48.0 %**
Business Administration (dom+int)	217	54.8 %		152	54.6 %	
Emergency Care (dom)	37	59.5 %		36	61.1 %	
Physiotherapy (dom)	53	67.9 %		49	69.4 %	
Sports and Health Promotion (dom)	55	63.6 %		52	61.5 %	
Tourism (dom)	60	78.3 %		54	79.6 %	
Hard-applied science base	**227**	**24.2 %**	**24.8 %**	**182**	**23.6 %**	**25.5 %**
Distributed Energy Systems (dom)	58	12.1 %		53	11.3 %	
Film and Television (dom)	66	42.4 %		57	42.1 %	
Information & Media Techn. (dom)	60	10.0 %		48	10.4 %	
Plastics Technology (dom+int)	43	32.6 %		24	33.3 %	
Total	**916**	**59.2 %**	**100.0 %**	**715**	**60.3 %**	**100.0 %**

*) dom = domestic students. int = international students

The international students (14%) were deemed too few and too diverse (32 nationalities) to be used in comparisons, and were therefore omitted. The average age among domestic students was 22 years, with 16 cases born before 1980, skewing the age distribution. These cases were also deemed too few and diverse (professionally active, family, i.e. non-typical students) to serve analysis, and were therefore omitted.

Thus, the analyses were performed on a rather culturally and ethnically uniform subsample of domestic students born after 1979, who had completed both the 'Me, ICT and media' survey and the level tests (n=715, Table 1). While reducing the amount of confounding variables, the sample uniformity may be regarded an advantage.
The resulting subsample was slightly female dominated especially within so called soft-applied sciences.[3] Within most degree programmes, the gender distribution deviated from sample total. Computer, smartphone and internet coverage was close to 100%, and the medians for computer, mobile phone and internet exposure varied between 10 and 12 years. For the survey and test items used in the present study, the completion rate was 97.8–100%.

Analysis methods

Data analysis follows in three steps: 1) user clusters are identified based on ICT use patterns, 2) ICTDL level tests are subject to a descriptive analysis, and finally, 3) results from previous steps are joined to analyse performance-based ICT skills within and across clusters in order to assess, which clusters justify for being regarded as Digital Natives based on both ICT use and ICT skills. For statistical tests, 0.05 was used as threshold for significance.

The survey 'Me, ICT, and media' included 55 items describing: use frequency and (self-reported) skills regarding computers (10), web activities (26), mobile phone activities (11) and news media (8) – see Figure 1 for a sample page of the survey. In previous studies, Helsper and Eynon (2010), Jones and Hosein (2010), van den Beemt et al. (2011), and Thompson (2013) used exploratory factor analysis to generate subscales. In the present study, however, the aim was to create use pattern subscales so that they serve cluster analysis by expressing each use pattern as distinctly as possible. Therefore, the choice was made not to compute the subscales as factor scores, since that would cause cross-loading items to reflect on two patterns (cf. 'Patterns of technology-based activities').

Instead, as demonstrated by Kennedy et al. (2010), Thompson (2013) and Büchi et al. (2016), pattern subscales were created by combining conceptually connected items. The subscale scores were then computed as unweighted averages of item values, but only when a required number (x) of valid values were available for each case (see MEAN.x, SPSS, 2016). 'Never used' was treated as valid values since they supply relevant information for forming clusters (Table 2).

Clustering is about grouping cases by similarity, that is, minimizing within-group variance and maximizing across-group variance (Bailey, 2005, pp. 889–890). The Two-step Cluster Analysis method available in the statistics package is designed to reveal natural groupings within large data sets (SPSS, 2016). Thus, Two-step Cluster Analysis was used to create the clusters using the use pattern subscale scores as input variables.

3. Degree Programme categorization modified from Becher (1994)

The level tests scores were analysed regarding overall descriptives, and One-Way and Welch Anova tests were used to assess if the score means differed significantly across clusters.

RESULTS

Use patterns and user groups

Patterns of technology-based activities

Table 2. Subscales based on frequency items (cf. Figure 1). The number after the subscale label indicates the number of valid values (x) required in the MEAN.x function syntax.

Subscale	Cases %	Cron-bach alpha	Predict. value in cluster analysis	Item-Total corr.
Items				
Versatile phone use (6)	98.2	.829	1.0	
use a mobile phone to browse the web				.678
use a mobile phone to send and receive email				.712
use a mobile phone to take digital photos or movies				.619
use a mobile phone as an MP3 player				.657
use a mobile phone to play games				.486
use a mobile phone as a personal organizer				.520
use a mobile phone for video calls				.440
Game playing (3)	97.1	.788	0.82	
play games on computer				.682
use web/LAN to play networked games				.694
play games on games console				.526
Sharing pictures and files (3)	98.2	.520	0.65	
use a mobile phone to send pictures or movies to other people				.339
use the web to share photographs				.366
use the web to upload and share MP3				.299
Digital news media use (3)	98.2	.648	0.62	
I follow the news using RSS feeds				.382
I follow the news on some newspapers' web sites				.449
I follow the news on some TV channels' web sites				.442
I use an app on my mobile phone to follow the news				.465
Blogging (3)	99.3	.760	0.47	
use the web to read other people's blogs or vlogs				.580
use the web to comment on blogs or vlogs				.668
use the web to keep my own blog or vlog				.554

Four of the use patterns were composed following examples in previous studies (pp. 91, 96), whereas 'Versatile phone use' was included in order to reflect smartphones being the new standard. The subscales showed good or satisfactory internal consistency (Table 2), and were further tested using Principal Component Analysis with Varimax rotation, where 15 out of 20 items single-loaded[4] on the anticipated factor (KMO=.866, Bartlett's Chi-Square=4746, df=190, p<.001, 60.2% of variance explained). The five items cross-loading were conceptually logical, for example, 'I use an app on my mobile **phone** to follow the **news**' loaded on both 'Versatile phone use' and on 'Digital news media use'.

User clusters

Clusters were generated using the use pattern subscales as input factors in the Two-step Cluster Analysis method that is capable of automatically selecting the number of clusters. In this case, a model containing five clusters was chosen since it contained rather equally sized clusters that differed clearly from each other regarding use patterns (Table 3, Figures 2–3).

Table 3. Five-cluster solution, distribution ratio 1.45.

Cluster	N	%	Mean age	Gender f/m %
Low-end users	136	19.8 %	21.2	76.5 / 23.5
Bloggers	161	23.4 %	20.8	87.6 / 12.4
Gamers	120	17.5 %	20.7	22.5 / 77.5
Communication-oriented users	159	23.1 %	21.3	56.6 / 43.4
High-end users	111	16.2 %	20.9	46.8 / 53.2
Total	**687**		**21.0**	**60.3 / 39.7**

Figure 2 illustrates which users engage in various activity areas: at least 80% of High-end users engage in all activity areas, whereas less than half of Low-end users engage in any activity area at all. Sharing pictures seems uninteresting for Low-end users, whereas all Gamers engage in some type of games. In general, Gaming is the most popular activity area, even among Low-end users. The largest differences appear within Sharing and Blogging.

4. ±.32 used as threshold for loading (Finch, Immekus, & French, 2016, p. 143).

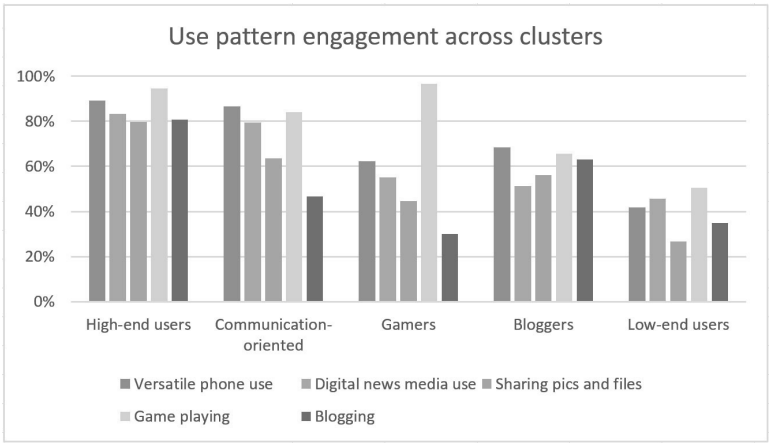

Figure 2. Technology based activity engagement across clusters. The bars express the portion of users that engage in some activity within the activity area, i.e. response>1 ('Never used').

Figure 3 provides a more detailed picture: the stacked bars represent frequency scores computed without the MEAN.x condition, but excluding 'Never used'. These frequency scores correspond to the questionnaire scale (Figure 1), and show for example that High-end users have an average activity level between 'Once/Several times a week', whereas Low-end-users lie between 'Every few months' and 'Once a week'. Just as all Gamers engage in some type of games, they also do so more frequently than any other cluster.

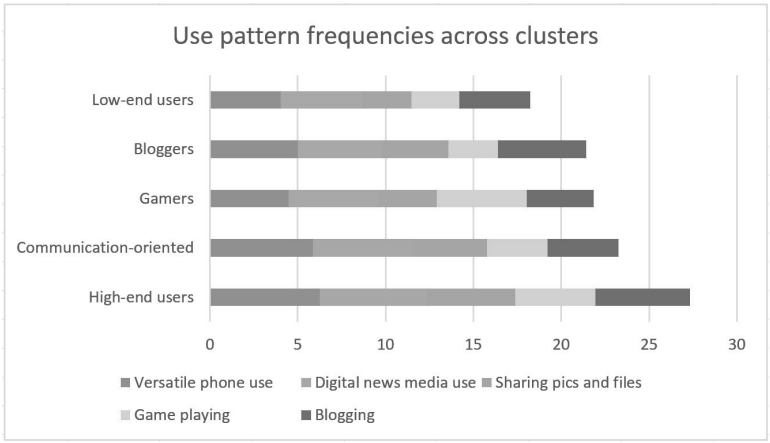

Figure 3. Use frequency means across clusters. The stacked bars correspond to the questionnaire scale (Figure1; 2='Once-twice a year'; 8='Several times a day').

The overall activity level is highest for Versatile phone use and Digital news media use (cf. nearly 100% smartphone coverage). The largest inter-cluster differences appear within Versatile phone use, Digital news media use and Game playing.

ICT skills

The overall descriptives of the test scores indicate that ICT skills are largely distributed, ranging over the whole scale from 0 to 10 in all modules. The ICT skills appear heterogeneous across modules, such that the students scored reasonably well in basic computer and internet use (module 1), with 63.1% demonstrating good skills. Regarding basic office tools (module 3), the mean score and the portion having good skills was lower (Table 4).

Table 4. ICT level test scores, overall descriptives.

Descriptives	**1. Computers & internet**	**3. Office tools**	**4. Information retrieval**	**5. Information security**
N	715	713	710	710
Mean	7.07	5.47	5.81	6.28
Median	8.00	5.67	6.00	6.50
Std. Deviation	2.84	2.90	2.15	2.15
Skewness	-0.805	-0.192	-0.522	-0.409
Kurtosis	-0.516	-1.084	-0.135	-0.304
Score distribution, %				
poor skills < 4 a)	16.9	30.2	17.9	14.2
medium skills 4–7 a)	20.0	30.6	46.2	42.1
good skills > 7 a)	63.1	39.3	35.9	43.7

a) Cut-offs according to ICTDL specification, resembling the Finnish school grades scale where 4 is the cut-off for passed. Students demonstrating poor skills were recommended tuition.

ICT skills across clusters

ICT skills are part of the characteristics attributed to Digital Natives (p. 90), which calls for comparing ICT skills across clusters. A rather heterogeneous picture emerged across both clusters and tests. The score distributions suggest that the modules have different ability in distinguishing the clusters, possibly due to different requirement levels (cf. p. 94). In modules 1 and 3, the scores are both largely (SD 2.84 and 2.90, Table 4) and differently (Figure 4) distributed, whereas in modules 4 and 5, the scores are less distributed (SD 2.15) and also show less inter-cluster differences.

Within clusters, the level test scores ranged over the whole scale from 0 to 10 in all clusters except among Gamers (Figure 4). The largest inter-cluster differences can be observed in module 1, where Gamers appear as the most homogeneous group (SD 1.93) as opposed to the Low-end users (SD 3.12).

A comparison across clusters using One-Way and Welch Anova tests indicated significant differences for all modules between several, but not all clusters (module 1: $F(4, 333)=20.27$, $p<.001$; module 3: $F(4, 681)=12.18$, $p<.001$; module 4: $F(4, 678)=6.81$, $p<.001$; module 5: $F(4, 330)=23.81$, $p<.001$). Gamers and High-end users appeared as top clusters, whereas Bloggers and Communication-oriented users appeared as middle clusters, and Low-end users as the bottom cluster with consistently lowest scores (Figure 4, tables available from author).

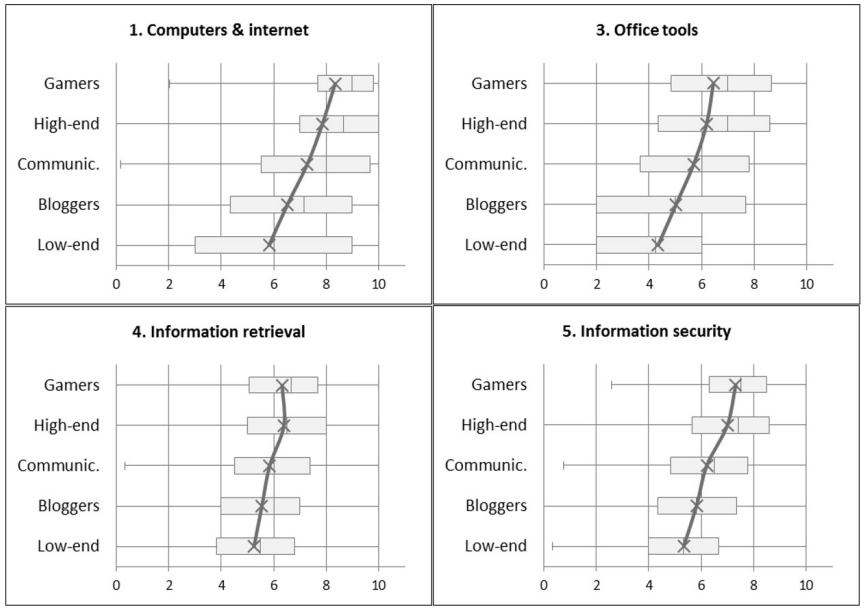

Figure 4. Level test scores across clusters.

An effect size analysis (Ellis, 2009) between the groups showed that the effect size between most adjacent groups (as ordered in Figure 4) was small ($0.2<$Cohen's $d<0.5$) but between other groups medium ($0.5<$Cohen's $d<0.8$). Large effect sizes (Cohen's $d>0.8$) occurred in module 1 between Gamers and Low-end users, and in module 5 between Gamers and Low-end users, and High-end users and Low-end users (effect size tables available upon request).

To conclude, within this sample, ICT skills are heterogeneously distributed both within and across clusters.

DISCUSSION

Methodological limitations

Prior to discussing the results, some comments regarding the instruments and methods are in order.

The ICTDL was broadly used since 2006 but unfortunately never validated. However, the test items and topics, based on learning outcomes defined in the curriculum, were carefully considered, continuously evaluated and improved by an expert team. The 3-point items, requiring both knowledge and skills, were built upon a problem-solving process that would produce only one correct answer. For both 1- and 3-point items, responses were entered in unambiguous format.

The differences between modules 1 and 3 versus 4 and 5 (Table 4, Figure 4) illustrate the challenge of creating tests that measure higher level skills (cf. van Deursen & van Dijk, 2009; van Deursen et al., 2012). Indeed, validating ICT skills tests would require standardization (cf. Aesaert & van Braak, 2015) which, in turn, would be contradictory considering the constantly developing ICT environment (versions, logic). Hohlfeldt et al. (2010) suggest that skills indicators should be 'appropriate expectations of technology-related knowledge' [for the intended user group], but with rapidly changing technology, 'appropriate expectations' must also constantly change. Tools for measuring ICT skills must be periodically updated (Huggins et al., 2014), and thus, after each (annual) update, a tool needs to be validated anew, which was not possible for the ICTDL. Still, statistics from the preceding years, where the tests had been updated annually, show mean scores close to those reported in Table 4 and a similar distribution across skills levels (tables available upon request), both suggesting stable measurement. That is, each year, each cohorts' ICT skills were about on the same level in relation to the current (updated) state of the art.

The SETQ (Gray et al., 2009) was jointly produced and refined by educational experts in three major universities, but unfortunately never validated. Updating the survey to conform to local culture and contemporary ICT and media environment ensured context fit. Most items showed a high response rate, indicating that the respondents understood the questions, possessed the information required to respond and answered truthfully (as in any self-report surveys). The items included in SETQ were never designed with subscales in mind. Thus, it is not relevant to consider the reliability of the SETQ, but rather the reliability of the subscales constructed in the present study. The subscales showed good internal consistency values and where it was conceptually expected, the items correlated moderately, indicating that they still measured different aspects.

Technology use patterns and clusters

Previous research (cf. Büchi et al., 2016; Kennedy et al., 2010) provided support for composing the subscales on a conceptual basis and in the present study, the PCA (cf. p. 98) supported both the subscales per se, as well as constructing them as unweighted means. The use pattern subscales (Table 5) resemble the ones described in previous studies (Jones & Hosein, 2010; Kennedy et al., 2010; van den Beemt et al., 2011; Thompson, 2013). The use pattern subscales inter-correlated to some degree, which seems conceptually reasonable: across clusters, use pattern activity levels show an obvious trend (Figure 2–3), with some exceptions (game playing, blogging). That is, since the subscales described patterns of technology-based activities, it is not far-fetched to imagine a latent, second-level "technology orientation" factor, influencing the use patterns.

Table 5. Use pattern subscales and their correspondence to previous studies.

Use pattern subscale	**Correspondence to previous research**
Versatile phone use	Technically Oriented use (Jones & Hosein 2010) Standard mobile use (Kennedy et al. 2010)
Game playing	Game-oriented use (Jones & Hosein 2010) Performing (van den Beemt et al. 2011) Gaming (Kennedy et al. 2010, Thompson 2013)
Sharing pictures and files	Web-interactive (Jones & Hosein 2010) Media sharing (Kennedy et al. 2010) Collaborative Web Tool Use (Thompson 2013)
Digital news media use	Reading news websites (van den Beemt et al. 2011, single item)
Blogging	Web Interactive (Jones & Hosein 2010) Interchanging or Authoring (van den Beemt et al. 2011) Web 2.0 publishing (Kennedy et al. 2010) Active Web Reading and Writing (Thompson 2013)

Both Kennedy et al. (2010) and van den Beemt et al. (2011) presented a four-cluster solution. In the present study, different solutions were tested, and as in previous studies, the High-end and Low-end users appeared in all solutions (Table 6). A solution with few clusters may turn out too coarse (cf. Kennedy et al., 2010), but allowing more clusters opens up for more nuanced information about the cluster characteristics. The clusters are naturally not identical with those described in previous studies, but share numerous similarities and serve exploration of inter-cluster differences.

Table 6. User clusters and their correspondence to previous studies.

Cluster	**Correspondence to previous research**
Low-end users	Basic or Irregular users (Kennedy et al., 2010); Traditionalists (van den Beemt et al., 2011)
Bloggers	Cluster 3 (Jones & Hosein, 2010); Irregular users (Kennedy et al., 2010); Traditionalists (van den Beemt et al., 2011)
Gamers	Cluster 4 (Jones & Hosein, 2010); Gamers (van den Beemt et al., 2011)
Communication-oriented users	Cluster 3 (Jones & Hosein, 2010); Ordinary users (Kennedy et al., 2010); Networkers (van den Beemt et al., 2011)
High-end users	Cluster 1 (Jones & Hosein, 2010); Power users (Kennedy et al., 2010); Producers (van den Beemt et al., 2011)

The cluster model had a fairly balanced factor predictor importance (Table 2), a rather even distribution (ratio 1.45), and clearly distinguishable use frequency and skills profiles (Figures 2–3), all speaking in favour of the model.

The **first research question** set out to explore what kind of groups can be identified based on ICT and media use patterns, and cluster analysis produced five clusters (Table 3). The subscales turned out balanced regarding predictive value (Table 2), that is, all subscales contributed to cluster construction without any of them dominating. Also, the input factor with weakest internal consistency, *Sharing pictures and files*, turned out relevant in distinguishing the clusters. The cluster solution distinguishes the clusters fairly well regarding both overall use activity (Figure 2) and use patterns (Figure 3).

Performance-based ICT skills

The comparison across clusters (Figure 4) showed that each module had a different capacity for distinguishing the clusters. With knowledge of how the questions and tasks in the modules were constructed, a possible explanation could be that modules 1 and 3 required both specific ICT knowledge and the skills to apply that knowledge in practical problem-solving (cf. p. 94). This supported the use of MCQ items with one specific answer, measuring exactly while scoring all or nothing. Unlike, in the subject area of Information seeking and Information security, knowledge was not that simply structured, and therefore more multiple-answer items were used. For the students, this allowed for easier deduction and collecting scores, for example by excluding the most implausible response options and choosing the most probable options. To conclude, not all subject areas lend themselves very well to computer-based testing in an open environment, at the expense of test accuracy.

A large part of the sample lacks the skills in using basic office tools (Table 4). This is problematic, firstly since these skills should be developed already in upper secondary as a preparation for higher education studies, and secondly since using those tools for producing texts with a scholarly approach is a central working method in higher education.

Responding to the **second research question** in the light of this sample, we can state that the young generation is heterogeneously ICT skilled. The ICTDL level tests scores ranged over the whole scale in all skill areas (modules), which supports previous research that has dismissed the assumption about all members of the young generation being net savvy (Helsper & Eynon, 2010; Kennedy et al., 2010; Kvavik & Caruso, 2005; van Deursen & van Dijk, 2009; van den Beemt et al., 2011).

Digital Natives among the young generation

Besides pronounced heterogeneity in performance-based ICT skills both across and within clusters, the results suggest that the competency profiles across clusters are on different levels (Figure 4), which allows us to discuss which clusters can be regarded as Digital Natives or Native-like based on both ICT use patterns (p. 99) and performance based ICT skills (p. 101).

High-end users (16.2%) engage frequently in a broad range of technological activities and perform very well in ICT skills tests. This cluster apparently holds users that correspond to the concept of Digital Natives.

Gamers (17.5%) show a high activity level on Gaming but varying levels in other areas. Gamers outscore High-end users on all except module 4, and a majority exhibit good skills in nearly all modules.

Communication-oriented users (23.1%) show an overall activity level higher than that of the Gamers, mostly due to Versatile phone and Digital news media use. Their ICT skills level is at medium level.

Bloggers (23.4%) are close to Gamers regarding overall activity but more active on Versatile phone use and Blogging. Bloggers exhibit medium ICT skills.

Low-end users (19.8%) are low in overall use, exhibit the lowest use frequencies except in Digital news media use, and have the lowest ICT skills scores.

Questions arise. Should Gamers, despite moderate use frequency, be regarded as Digital Natives due to their high level test scores? Should Communication-oriented users' use frequency alone justify them for being regarded as Digital Natives?

The above assessment will not sum up into a clear-cut statement, declaring which of the clusters are Digital Natives. Instead, it seems obvious that the use pattern-based characteristics (pp. 97–98) are not exclusive, but rather overlapping and occurring to varying extents in the different clusters. The same applies for the ICT skills that turned out to cover the whole scale in all clusters. Thus, all the Digital Natives characteristics, that is, both use patterns and skills, are widely distributed, which supports the view of Helsper and Eynon (2010) regarding Digital Nativeness as orientations or characteristics on a continuum.

To conclude, we can respond to the **third research question** by stating that High-end users correspond very well with what has been described as Digital Natives, and we can be confident in positioning them at the Digital Natives pole of the continuum. Gamers are positioned next to them, and Communication-oriented users somewhere towards the middle. Low-end users are positioned at the non-Digital Native pole of the continuum and the Bloggers next to them.

For those readers expecting a numeric answer, we may conclude that around 16% of this sample (High-end users) resemble so-called Digital Natives strongly, whereas around 18% (Gamers) can be described as Digital Native-like. Around 23% (Communication-oriented users) resemble Digital Natives weakly, and the remaining 43% (Low-end users and Bloggers) do not resemble Digital Natives. Thus, around a third of the young generation may be regarded as Digital Natives, which supports previous studies (pp. 90–92) that refute assumptions of a homogeneous Net Generation.

CONCLUSIONS AND FUTURE DIRECTIONS

The subsample represents speakers of a minority language (Swedish), but in general, the background population is close to the national average. Still, the conclusions are not to be generalized, but serve as a contribution to the discussion about the heterogeneity of the young generation and the prevailing digital divide.

The results support previous studies regarding the Net Generation being just as heterogeneous as any other cohort and furthermore, also the clusters resembling Digital Natives contain users with rather poor ICT skills, which refutes the assumption of net savvy Digital Natives.

As the results above show, the ICT skills among the young generation are diverse, limited and do not necessarily match the requirements in higher education studies, increasing the risk of a digital divide. The results indicate that we still suffer from a secondary and tertiary level digital divide (p. 91), that is, all users do not manage to develop their skills to such a level that they would be able to fully utilize the advantages of ICT, for example, in their studies. Acknowledging these divides is a necessary step for taking measures to overbridge them.

Future research regarding ICT usage and related background factors needs to pay attention to all the circumstances for use, that is, not only to material, temporal and spatial access, but also to how the surrounding culture supports ICT use and developing skills (cf. North et al., 2008; van Dijk, 2008, p. 290; Robinson, 2009; Gui & Argentin, 2011).

In future work by the author, Digital Nativeness will be further explored in connection to students' epistemic beliefs and how they occur across different clusters within the young generation.

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PUBLICATION II

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Epistemic Beliefs and Googling

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Abstract

With the introduction of internet as a source of information, parents have observed youngsters' tendency to prefer internet as a source, and almost a reluctance to learn in advance since "you can look it up when needed". Questions arise, such as 'Are these phenomena symptoms of changing beliefs about knowledge and learning? Is it at all possible to learn on a deeper level simply by looking up the basic facts, without memorizing them?'

Within an existing line of investigation, epistemic beliefs have been described as a set of dimensions. Although internet-based information and internet as a source of information have been acknowledged, studies so far have not explored how dealing with internet-based information relates to other epistemic beliefs dimensions.

To capture how users view internet-based information per se but also in relation to other epistemic beliefs, I suggest three new dimensions, out of which the most crucial is labelled 'Internet reliance'. Offloading memory using memory aids is not a new phenomenon but the 'Internet reliance' dimension indicates that especially internet-reliant users may be confusing external information with personal knowledge, with all the risks it may entail.

Besides including beliefs about learning, this study also challenges earlier assumptions regarding uncorrelated dimensions.

Keywords: epistemic beliefs; internet; constructivism; outsourcing knowledge; factor analysis.

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1 Introduction and aim of study

During the last decade, most people will have heard youngsters respond to a question with the acronyms JFGI or GIYF (*"Just F...g Google It"* and *"Google Is Your Friend"*, see https://en.wiktionary.org/wiki/JFGI). For most adults, expecting a proper answer, this response was surprising, puzzling and perhaps even offensive. The response is, however, an illustration of the gap between the parent generation's "You should know this"-view on knowledge, and the young generation's stance "I'll look it up when I need it".

With the introduction of easy and ubiquitous access to information over internet, the attitude of looking it up when one needs it became common, especially among frequent internet-users. Given that the young generation born after the mid 1980's grew up surrounded by information and communications technologies (hereafter ICT), the interesting question is, has the easy and ubiquitous access to information actually influenced their view on knowledge, knowing and learning?

During the first decade of this millennium, the so-called Digital Natives of the Net generation were supposed to hold characteristics such as being constantly on-line, being ICT savvy and being at home on social media (e.g. Prensky, 2001; Siemens, 2005). Indeed, the youngsters differ from their parent generation in that they lack a personal history of the time before mobile phones, internet and search engines (Gunter, Rowlands, & Nicholas, 2009, p. 3), not to mention smart phones. Large parts of the youngsters within this cohort embrace the opportunities provided by ICT, e.g. preferring internet-based information instead of books (cf. OSF, 2010; Purcell et al., 2012, p. 4). Still, several studies have pointed out the heterogeneity within the generation (cf. Jones & Hosein, 2010; van den Beemt, Akkerman, & Simons, 2011). Also among the students participating in the present study, large differences occurred regarding both self-reported ICT and media use patterns and performance-based ICT skills (Ståhl, 2017).

Within education, the easy and ubiquitous access to information raises concerns about how and upon which information students build their knowledge, since they seem to accept the veracity of on-line information too easily, and lack the skills of thinking critically and synthesizing the information found on-line (Purcell et al., 2012, pp. 26-27). The vast popularity of search engines (with covert operating logics) in combination with users' lacking critique has considerable epistemic implications, as demonstrated in the theoretical work and the studies cited below (section Knowledge and information in the internet era). The present study will build upon the above studies that confirm the existence of the JFGI phenomenon.

Existing self-report instruments for measuring epistemic beliefs are not capable of capturing signs indicating internet-induced changes in the views of knowledge and learning. Especially the Digital Natives' ways of dealing with knowledge and learning have been described in literature (some examples in section *Hypothesized dimensions*) but so far, this topic has been scarcely approached from an epistemic point of view. This topic calls for empirical investigation, which requires instruments.

This paper will describe how the existing dimensions (*Structure and Certainty of knowledge, Innate learning ability* and *Omniscient authority*) are extended with the new dimensions *Constructivist approach, Internet reliance* and *Learning by dialogue*. Creating a validated instrument requires more than one round and therefore, the aim of this endeavour is an initial exploration of how new dimensions might contribute to a better description of how today's higher education learners in an internet-saturated context view knowledge and learning.

Contemporary research regarding epistemic beliefs largely subscribes to epistemic beliefs being limited to beliefs about knowledge, and not about learning. The present study will deviate from this view by exploring also views about learning. Doing so, this study contributes to the discussion by looking beyond the knowledge dimensions of epistemic beliefs, and by describing the connection between beliefs about knowledge and beliefs about learning, a connection that is necessary to illuminate consequences for educational practice.

2 Personal knowledge, external information

To provide a rationale for the present study, this section will

1) review some studies regarding knowledge, information and epistemic beliefs in the internet era,
2) review epistemic beliefs as a research area,
3) review some arguments regarding learning as part of epistemic beliefs, and
4) discuss why domain specificity and justification of knowledge where omitted from the study at this stage.

2.1 Knowledge and information in the internet era

George Siemens tried to grasp the impact of technology and the decreasing half-life of knowledge by introducing connectivism as a new learning theory for the digital age. He suggested supplementing the existing forms of propositional (knowing-that) and procedural (knowing-how) knowledge with 'knowing-where' and 'knowing-who', i.e. an understanding of where to find knowledge. According to Siemens, since we cannot experience everything or store all knowledge ourselves, we store knowledge in other people and in non-human appliances. The key is connectedness, and the knowledge is distributed (Downes, 2007, p. 84; Siemens, 2005). Connectivism was apparently neither a learning nor a knowledge theory but rather a pedagogical view but still, the connectivist ideas resemble the concept of distributed mind, which suggests that knowledge can reside in people, in tools, and in cultural settings, and that the potential lies in the combination of those (cf. Shaffer & Clinton, 2006).

The results of an experimental study by Sparrow and her team suggest that internet has become a kind of extension to our individual memory system. If the net is available, we do not bother to memorize the information itself but rather, where to find the information, as when youngsters respond: "JFGI!" We are becoming increasingly symbiotic with our computer-based tools, growing into interconnected systems that remember less by *knowing information* than by *knowing where to find* the information. (Sparrow, Liu, & Wegner, 2011)

The concept of the extended mind (Clark & Chalmers, 1998) suggests that human cognition may extend beyond the brain and include elements from social and technological environments (cf. Siemens, 2005). Applying the concept to the context of the web opens up for the concept of the web-extended mind, which includes the idea that *"... the informational and technological elements of the web can, at least on occasion, constitute part of the material supervenience base for (at least some of) a human agent's mental states and processes"* (Smart, 2012, p. 451). The mere existence of the web does not automatically make it part of a person's extended mind but in addition, three criteria need to be met: the availability criterion, the trust criterion and the accessibility criterion (Clark & Chalmers, 1998; Smart, 2012). Considering the development, that has taken place within the web and smart phone contexts since Smart wrote his article, we have reason to suspect that users often regard these criteria as met, and too easily incorporate on-line information into their personal body of knowledge: due to internet capable smartphones, the availability and the accessibility criteria are easily met. The problematic part is the trust criterion: on-line information is too easily endorsed and too rarely subject to critical scrutiny (Purcell, Brenner, & Rainie, 2012, pp. 10-11). This is especially problematic since e.g. Google made personalized search in 2009 the default option for all users (Simpson, 2012, p. 437).

The personalization of search results performed by search engines means that the results are tailored to what will probably interest the enquirer, and that those hits that do not fit the enquirer's profile are ranked down or even omitted. According to Thomas Simpson (2012), the epistemic significance of search engines lies in their acting as surrogate experts, firstly as they assist the enquirer in finding sources and secondly as they orient the enquirer to supposedly relevant sources of information (the expert role also discussed by Fisher, Goddu, & Keil, 2015, below). The problematic aspect here is that by filtering and ranking the results, the search engine implies a judgment about what is relevant, without the enquirer having neither insight into, nor the possibility to influence the criteria for judgement. As Simpson (2012, p. 427) puts it: *"... objectivity may require telling enquirers what they do **not** want to hear, or are **not** immediately interested in"* (my emphasis)

(also see Hinman, 2008). Therefore, Simpson regards personalization as an actual threat to objectivity. By *leaving out relevant voices*, the tailored search results contribute to an epistemic bubble, and the operating logics of search engines combined with the enquirers' ignorance increases the risk of the enquirer being trapped in an epistemic bubble or even an echo chamber (Nguyen, 2018).

The complexity of the objectivity problem is illustrated by the findings of Purcell, Brenner, & Rainie (2012): although a majority in their study disapproved search engines collecting information about their searches, 23-29% thought that using the information for personalizing search results was a positive feature (pp. 19-21). Further, on average two thirds of the participants believed that the information provided by search engines was fair and unbiased: the younger, the more they relied on search engines' objectivity (pp. 10-11). A further aspect, illustrating the objectivity problem, is the ritualization described by Bhatt & MacKenzie (2019), i.e. students' information seeking practices being largely motivated by adhering to what they call the rules of the game. These rules can be appropriate in the beginning to induce students to the knowledge creation practices of the discipline but when detained too long, they may inhibit the development of students' information seeking skills and trust in their own capacity to consider the justification of the information they find.

In an experimental study, Fisher et al. (2015) highlight the risks embedded in ubiquitous access to information, which may blur the boundaries between personal knowledge and external information, thus creating an illusion of possessing personal understanding. Further, their results suggest that some individuals tend to regard internet as an expert regardless of domain. These results pose a true challenge for education at all levels, at least if we consider personal and integrated knowledge, instead of loose bits of information, as the objective of education and learning.

Miller & Record (2013) discuss the covert operating logics of search engines and their epistemic implications using a framework building upon a responsibilist account of justified belief. According to this, an epistemically responsible enquirer will aim at having true beliefs and will therefore perform all the necessary actions to collect sufficient evidence to support his belief, such as checking a broad enough range of e.g. web pages and comparing them to other types of sources (cf. Bråten, Brandmo, & Kammerer, 2018). There are, however, three cases where the enquirer may fail to acquire justification for his belief: 1) the enquirer neglects performing a proper search, 2) the enquirer performs a proper enquiry, but the results do not support his belief or 3) the activity to justify his belief is not possible, e.g. due to lack or impracticability of a technology. Assuming that an enquirer is literate enough to avoid the first case, he can still fail as in cases 2 and 3. In cases of internet searches the problem is that, due to the covert search logics, the enquirer may not even know that he has failed. He may believe that he has performed a proper search but, due to the search engine's filtering and ranking, the results may not provide the full picture of facts required to justify or rule out the belief. Furthermore, due to the covert operating logic, it is impracticable (case #3) for the enquirer to assess the quality of the set of sources provided by the search engine.

As shown above, the past decades' technological development has induced changes in how individuals acquire information, and blurred the boundaries between personal knowledge and external information. The problem is not about using external memory aids or systems for offloading information (Säljö, 2012). As Säljö explains, man started developing external symbolic storages and artificial memory systems thousands of years ago, and memory aids such as Otto's physical notebook (Smart, 2012) or address books in smartphones are everyday tools used to offload information from our memory. However, there is a risk that (especially young) users not only *offload* information but perhaps even *outsource* cognitive processes, since they may lack the epistemic competencies and practices required in this new information ecology (cf. Bhatt & MacKenzie, 2019; Fisher et al., 2015; Säljö, 2012; Sparrow et al., 2011).

To provide a rationale for the approach of this study, the following sections will briefly review 1) epistemic beliefs as a research area, 2) how epistemic beliefs may relate to learning and 3) dimensions and tools for measuring epistemic beliefs. These sections also aim at explaining how this study was delimited and why some aspects, albeit frequently discussed in other studies, were not included in this study.

2.2 Epistemic beliefs as a research area

William G. Perry's (1970) study of college students' ideas regarding Source and Certainty of knowledge is commonly regarded as the starting point for research on epistemic beliefs or personal epistemology Over the past decades, epistemic beliefs have been conceptualized in different ways (cf. Schraw, 2013). Some researchers conceive them as broad and developing stage-like. Other researchers conceive them as a set of more or less independent dimensions expressing beliefs about knowledge and learning, Marlene Schommer (1990; 1993) being the first in this line of research. The term 'epistemic beliefs' will be used here since the study will focus on the respondents' (implicit and unconscious) views of knowledge, not their theories of knowledge or epistemology (cf. Kitchener, 2002; Hofer, 2008, p. 5).

The works during the 1990ies of Marlene Schommer (1990; 1993, later Schommer-Aikins) and Barbara K. Hofer and Paul R. Pintrich (1997) in developing research around epistemological theories are important to acknowledge. During the first decade of this century, research around epistemic beliefs increased and extended from Perry's original North American, white, elite, male college students context to other age groups and geographical and cultural contexts. For extensive overviews, please see the works by Hofer & Pintrich (2002), Niessen, Vermunt, Abma, Widdershoven, & van der Vleuten (2004), deBacker, Crowson, Beesley, Thoma, & Hestevold (2008) and Khine (2008). Further, the more recent works by Schraw (2013) Greene, Sandoval, & Bråten (2016), Bernholt, Gruber, & Moschner (2017) and Knight et al. (2017), out of which the four latter where not yet available at the time for planning this study.

Domain-specificity and domain differences have been issues throughout the years. The initial assumption, that one's epistemic beliefs are general across domains, has been questioned and instead, it has been suggested that one can hold different epistemic beliefs, depending on the field of knowledge one is dealing with (Muis, Bendixen, & Haerle, 2006). The longitudinal study by Trautwein & Lüdtke (2007), albeit focusing on the certainty dimension only, confirmed the hard-soft difference but also that students aiming at certain college programmes differed regarding their beliefs already at the end of their upper secondary education. In their large review, Muis et al. (2006) noted that empirical research had been presented in support for both domain general and for domain specific epistemic beliefs respectively, and that they may co-exist and possibly interact. The suggestions by Muis et al. were strongly supported by both Hofer (2006) and Alexander (2006). To conclude, I acknowledge the co-existence of and interaction between domain-general and domain-specific epistemic beliefs. The question regarding domain-generality vs. domain-specificity was, however, not the focus of the present study.

The development of self-report instruments for measuring epistemic beliefs has encountered several challenges. In his review article, Schraw notes that there has been disagreement about the underlying conceptual structure, and replications of exploratory factor analyses (hereafter EFA and CFA will be used for exploratory and confirmatory factor analysis, respectively) have often failed. Common problems have been that items load in an unexpected manner often resulting in less factors or another factor structure than anticipated in the underlying conceptual model, too few items loading per factor and the resulting model showing a low explanation score. (Schraw, 2013)

In the present study, I will subscribe to the line of research that considers the concept of epistemic beliefs as multidimensional. Assuming that hitherto described dimension sets are not sufficient to describe epistemic beliefs in the new information ecology, I attempt to introduce some new dimensions. The aim of testing new dimensions required starting on a general level and therefore, the questionnaire items (except for the internet-related items) did not refer to any specific discipline or context (section Instrument construction).

2.3 Epistemic beliefs and learning

Alongside with motivation and cognitive styles, the concept of epistemic beliefs is an important factor affecting learning and study success. Hofer & Pintrich (1997) called for more research to understand how students' epistemic beliefs may influence learning performance. Further, they suggested that the type of learning tasks may shape the students' epistemic beliefs, as shown later by Kienhues, Bromme, & Stahl (2008).

Brownlee, Walker, Lennox, Exley, & Pearce (2009) approached the topic of epistemic beliefs qualitatively, and their results highlight that first-year students may hold subjectivist or objectivist core beliefs that may decrease their ability to engage in critical thinking, required in higher education. Walker et al. (2009) also approached first-year students and identified some students being at risk of having difficulties in higher education due to their naïve beliefs about learning and knowing.

There is also evidence suggesting cultural differences. Zhang & Watkins (2001) observed that Chinese students' cognitive-developmental patterns were the opposite of the patterns observed in the U.S. sample. Their results also indicate that epistemic beliefs are not static but developing (cf. Kienhues et al., 2008). Further, Hofer (2008, pp. 11-12) observed differences between Japanese and US college students such that US students had more sophisticated beliefs about the factors describing certainty, simplicity, source and justification of knowledge.

Education is moving towards methods of teaching and learning that often involve using Internet-based resources (e.g. the flipped classroom, Knewton, 2011). These methods require more self-regulation from part of the student, and e.g. Bråten (2008, pp. 369-370) highlights the risk that students with naïve epistemic beliefs may tend to over-reliance towards internet-based resources.

Regarding the changes in teaching methods, it is worth noting that the teachers' choices of pedagogical activities and learning settings are also influenced, perhaps unconsciously, by the teacher's own epistemic beliefs (Palmer & Marra, 2008, p. 337). An overall awareness regarding epistemic beliefs is called for among teachers at all levels of education. An interesting attempt to support this awareness is the theoretical model between epistemic beliefs and self-regulation suggested by Muis (2007), where epistemic beliefs facilitate self-regulation and play a crucial role in all four phases (Task definition, Goal setting, Enactment and Evaluation) of the learning process.

An example from a constructivist education context (PBL) is the study by Otting, Zwaal, Tempelaar, & Gijselaers (2010), where the results showed a connection between conceptions of expert knowledge and traditional conceptions of teaching and learning on one hand, and on the other hand a connection between learning effort and a constructivist conception of teaching and learning.

The examples above illustrate that there is much going on within the educational context, most importantly that education is moving from being teacher- and subject-centred towards being more student- and learning-centred. The development of the technological structures around ICT is increasingly beyond control of the educational system. However, learning analytics is an area where education is actively applying ICT: the core characteristic is the generation of high-resolution data about various types of [learning] actions (Knight, Wise, & Chen, 2017), and applying knowledge from multidisciplinary perspectives such as business intelligence, web analytics and data mining for analysis purposes (Ferguson, 2012). Thus, learning analytics can generate real-time individual and group performance information with potential to support teachers' decision-making (Knight, Wise, & Chen, 2017). Knight et al. (2017) present a novel approach as they explore how students' epistemic beliefs predict e.g. students search behaviour (traced using learning analytics methods). Their results did not show a convincing predictive value, whereas the results by Pieschl, Stallmann, & Bromme (2014) were a bit more encouraging. This issue is further commented in section *Internet-specific epistemic beliefs*.

2.4 Dimensions and measurement

Within the line of investigation that regards epistemic beliefs as multidimensional, self-report instruments have been developed to capture the dimensions of epistemic beliefs. In her original 63-item Schommer Epistemological Questionnaire (SEQ), Schommer (1990; 1998) suggested the dimensions *Simple knowledge*, *Certain knowledge*, *Innate ability, Quick learning* and *Omniscient authority*. Using EFA, Schommer managed to extract four but not the Omniscient authority dimension. Thus, the dimensions described views on both knowledge and learning. Several authors (e.g. Hofer & Pintrich, 1997) have criticized Schommer for not performing factor analysis on the 63 original items but using 12 subscale scores (packages)

based on those items, as variables. Still, Schommer's questionnaire has been the starting point for a large part of later development regarding questionnaire-based instruments (for an overview, please see Niessen et al., 2004), out of which the following instruments, besides the SEQ, were used as reference in the present study:

- Wood & Kardasch (2002) developed the *Epistemological Beliefs Survey* (EBS) containing 38 items, out of which 32 stemmed from or resembled items in the SEQ, and covering two SEQ dimensions.
- Schraw, Bendixen, & Dunkle (2002) developed the *Epistemic Beliefs Inventory* (EBI) containing 28 items, out of which 17 stemmed from or resembled items in the SEQ. EBI reflected the same dimensions as the SEQ.
- Moschner, Gruber, & Studienstiftungsarbeitsgruppe EPI (2005) developed the 43-item *Fragebogen zur Erfassung epistemischer Überzeugungen* (*Questionnaire for capturing epistemic beliefs*, hereafter FEE) containing nine items from SEQ. FEE included the three SEQ dimensions *Certainty of knowledge, Learning ability and Omniscient authority*. Additionally, the FEE proposed five new dimensions labelled *Social aspects of knowledge, Value of knowledge, Culture related aspects of knowledge, Gender related approaches to knowledge* and *Reflective nature of knowledge*.

2.4.1 Knowledge, knowing and learning

The discussion whether epistemic beliefs should be limited to beliefs about knowledge and knowing, or whether beliefs about learning should be included, has been ongoing throughout the decades. Hofer & Pintrich (1997) recommended excluding beliefs about learning for the sake of clarity of the concept of epistemic beliefs. Instead, they retained Certainty and Simplicity of knowledge (describing *nature of knowledge*) and proposed the dimensions Source of knowledge and Justification for knowing to describe the *nature of knowing*.

Schommer introduced an embedded systemic model that included *Beliefs about Ways of Knowing*, interplaying with *Beliefs about Knowledge* and *Beliefs about Learning*, i.e. beliefs about knowledge and learning as separate constructs but within the same system (Schommer-Aikins, 2004).

Sandoval (2005) warned for conflation of the concepts. Although beliefs about knowledge will probably influence one's beliefs about learning, Sandoval proposed that they should be investigated as separate constructs. In a comment to the discussion, Elby (2009) suggested that it is too early to decide and therefore, views on learning should at least for the time being be included in the concept of epistemic beliefs for further empirical and theoretical development.

For the present study, data were collected regarding beliefs about both knowledge and learning and consequently, the analyses include both aspects. This approach is also supported by previous research presented in the section Epistemic beliefs and learning.

2.4.2 Internet-specific epistemic beliefs

The point of departure for this study, the tendency not to look up information until needed and to rely on internet-based sources, is close to the research regarding internet-specific epistemic beliefs by Bråten, Strømsø and their teams. In 2005, they developed the Internet Specific Epistemic Questionnaire (ISEQ: Bråten, Strømsø, & Samuelstuen, 2005), which was based on the four dimensions described by Hofer & Pintrich (1997) and thus omitting learning dimensions. In performing EFA, Bråten et al. used Maximum Likelihood (hereafter ML) as extraction method together with an oblique rotation method but did, however, extract only two factors. They labelled the first one *General Internet Epistemology*, which included beliefs concerning the certainty and simplicity of Internet-based knowledge, as well as beliefs concerning the Internet as a source of knowledge, i.e. three dimensions in one factor. The second factor was labelled *Justification for Knowing* and described whether internet-based knowledge claims could be accepted without critical evaluation, or should they be critically evaluated using multiple sources, reasoning and prior knowledge.

All eighteen ISEQ items referred to internet and thus, all questions connected explicitly and exclusively to the internet context. Further, when reading the ISEQ *General Internet Epistemology* items it seems obvious that they do not actually reflect the certainty or structure of *knowledge* (cf. corresponding items in Table 1) but rather, they mainly express the coverage and availability of information on the internet. Thus, the ISEQ seems to leave questions open about the respondent's beliefs regarding certainty and simplicity of knowledge in general, about the beliefs regarding other sources of knowledge, and how these beliefs relate to each other; unanswered questions constituting a research gap.

In a subsequent study, Bråten & Strømsø (2006) applied parts of the SEQ (Schommer, 1990), but not the ISEQ, to explore the connection between epistemic beliefs and internet-based search and communication activities. It turned out e.g. that students who believed in quick learning tend to overlook the importance of critically evaluating web-based resources. In another study, based on 17 out of 18 items in the ISEQ item set, the authors extracted only three factors (using ML and Direct Oblimin): *Certainty and source of knowledge*, *Justification for knowing* and *Structure of knowledge* (Strømsø & Bråten, 2010).

The ISEQ has also been applied in other contexts and for other purposes: Karimi (2014), exploring the connection between internet-specific epistemic beliefs and grammar achievement, extracted the same three factors as Strømsø & Bråten (2010), although with Varimax rotation. Chiu, Liang, & Tsai (2013) used a Chinese translation of the ISEQ, and applied an EFA method (apparently with oblique rotation) but upon only twelve items. These authors did, however, not extract ISEQ dimensions as described by Bråten et al. (2005) but instead, the four dimensions originally suggested by Hofer & Pintrich (1997), i.e. Certainty, Simplicity and Source of knowledge and Justification for knowing, but using items specifically denoting an internet-based context. Kammerer & Gerjets (2012) applied ISEQ to categorize users for comparison, but they only used eight items attributed to the ISEQ-dimension Certainty and Source of knowledge and thus, did not test the factor structure proposed in the original ISEQ.

The study by Knight et al. (2017) exemplifies a research approach linking epistemic beliefs with log data analytics. They used the ISEQ in an extensive study to explore whether the two-factor ISEQ scores could predict e.g. trustworthiness ratings of internet-based sources or traced search behaviour. According to their results, the factor scores did not predict search behaviour, and they had only small predictive value for trustworthiness rating. The approach by Knight et al. is interesting and relevant but raises the question: Could the connections to search behaviour have turned out differently had they not used the two-factor ISEQ, where the General Internet Epistemology factor contains a mix of Certainty, Structure and Source of knowledge? E.g. the results by Pieschl et al. (2014), indicate that students' epistemic beliefs influence how they approach complex tasks.

To conclude, epistemic beliefs have been explored also in relation to internet-based information, but the picture is disparate. The studies referred to above, as well as many other studies, suffer from the problems addressed by Schraw (2013). The studies published prior to the present data collection (Bråten et al., 2005; Bråten & Strømsø, 2006; Strømsø & Bråten, 2010) focused on beliefs about internet-based information without actually relating these beliefs to beliefs about knowledge based on other information sources. The studies referred to above also leave the question open, whether internet should be regarded as an authority or knowledge source, or a specific context (cf. Grossnickle Peterson, Alexander, & List, 2017, p. 262).

2.4.3 Justification for knowing

Hofer & Pintrich (1997) introduced *Justification for knowing* as a dimension, which was later supported by several researchers. Both Alexander (2006) and Greene, Azevedo, & Torney-Purta (2008) have noted that this dimension is least developed, and that exploring justification is more challenging than exploring other dimensions. This assumption seems well founded considering the complexity of the justification aspect, e.g. in terms of the responsibilist account of justified belief suggested by Miller & Record (2013) (see section Personal knowledge, external information).

Greene et al. (2008) point out two aspects that are part of the challenge in investigating the justification dimension. First, considering the number of different kinds of justification identified in philosophy, justification as part of the epistemic beliefs model will probably require to be described by multiple factors rather than one single factor. Further, Greene et al. suggest that a person needs to have a sophisticated ontology of a domain before issues of justification, such as critical thinking, become relevant. This seems congruent both with Bloom's original cognitive process dimensions and especially with the knowledge dimensions described later by Krathwohl (2002): issues of justification are probably far more relevant when applying, analysing or evaluating conceptual knowledge than when recalling facts.

The above suggestion by Greene et al. comes to expression in a recent study by Bråten, Brandmo & Kammerer (2018), where they delimit the context to internet and the domain to that of educational topics within teacher education. Their study focuses solely on the justification dimension, approaching it as a three-dimensional concept including justification by authority, justification by multiple sources and justification against prior personal knowledge and reasoning. As a result, they present the validated Internet-Specific Epistemic Justification Inventory (ISEJ).

Against the background of the considerations referred above, and the fact that epistemic beliefs in the new information ecology was totally uncharted territory, it seemed appropriate to leave the *Justification* dimension outside this investigation. Hence, the FEE instrument (Moschner et al., 2005) was chosen as a starting point (see section Instrument construction).

2.5 Research questions

Capturing all dimensions of epistemic beliefs (or cognition, cf. Greene et al., 2008) while at the same time adding and testing new dimensions would be both adventurous and beyond this study. Therefore, while acknowledging that epistemic beliefs consist of multiple dimensions developing over time, this study adopts a narrow focus on capturing a snapshot of the participants' current epistemic beliefs, including beliefs in internet-based information. Thus, the *Justification* dimension as well as the topics regarding subject-, domain-, discipline-, culture- or gender-specificity of epistemic beliefs (see e.g. DeBacker et al., 2008) are beyond the scope of this study.

The approach of this study is openly explorative in testing whether it is possible, overall, to extend the existing instruments and their dimension sets with new dimensions of epistemic beliefs, and specifically to capture such ways of relating to knowledge that have become common among frequent internet users during the past decades. Further, this study will explore the relation between existing epistemic dimensions and those describing internet-based knowledge and knowing.

Apart from ISEQ (Bråten et al., 2005), this study does not aim to explore how individuals justify internet-based information, but rather to explore whether and to which extent individuals rely on and prefer internet-based information sources, and how this preference relates to other epistemic dimensions. The investigation is framed in a single research question:

> ***(How) can the set of epistemic beliefs dimensions be extended so that it also expresses a googling attitude?***

The research question is openly phrased since, although research on epistemic beliefs has been going on for some time, the proposed dimensions are on uncharted territory. For the sake of clarity, I will use the term *original dimensions* for those dimensions described in or stemming from Schommer's SEQ (1990). *Hypothesized dimensions* will be used to denote suggested dimensions until their existence has been confirmed, after which they are denoted as *novel dimensions or scales* in the proposed model, which is the endpoint of the present study.

3 Material and methods

By way of introduction to this section, I provide a rough outline for instrument construction and data collection. The first version of the instrument was created for the data collection in August 2011. The instrument was evaluated so that a revised version was used for the second data collection in August 2012, which resulted in the material being reported here. The usability and validity of data from 2012 is commented in the discussion section. It needs to be noted, that after the current data were collected, new studies describing further development have been published. The present instrument was, naturally, based on instruments that were published and available prior to 2012.

3.1 Instrument construction

The FEE questionnaire developed by Moschner et al. (2005) combined experiences from previous instruments and also contained some potentially interesting extensions. Therefore, the FEE was taken as point of departure for constructing the first version of the on-line survey called 'Me and my knowledge'. A replication of using the FEE-specific items was performed on the first data set collected in 2011 (reported in Ståhl & Mildén, 2017). Due to unsuccessful replication, the instrument was revised prior to the 2012 data collection: the five new dimensions suggested in FEE were omitted, *Structure of knowledge* items were included as well as some other items, based on item level analysis. In addition, some items describing the hypothesized subscales were reversely phrased. Table 1 shows the entire instrument, item descriptives and item associations before and after analyses.

Since Swedish and English are the working languages of the university, the questionnaire was set up in both languages. To ensure comprehensibility, both Swedish-speaking domestic and English-speaking international students were involved in read-aloud sessions during instrument construction.

An important aspect of the cultural adaptation of the questionnaire was rephrasing the questions into first person present tense, as suggested e.g. by Kitchener (2002) and Schommer-Aikins (2004, p. 23). The main motive was to ensure a first-person perspective: the phrasing should clearly signal that the researchers were interested in knowing what the student herself thinks, not what she thinks that people in general think, or what is socially desirable to think about a topic. During the read-aloud sessions, the students provided valuable feedback acknowledging the need for cultural adaptation and inducing some further rephrasing. Overall, the students' feedback supported the choice to use direct and active wording. The items were consistently generic (not domain- or discipline-specific), and the instructions did in no way refer to relating the responses to any specific subject, academic field or context (cf. Wood & Kardash, 2002, p. 244; Muis et al., 2006, p. 25).

Table 1

Questionnaire items in original and hypothesized dimensions, including item descriptives and item use in the proposed model

Original/ hypothesized dimension	Item # [a]	Item label	Mean	Median	Std. Deviation	Skewness	Kurtosis	Original/ novel scales [b]
Certainty of knowledge	k03_8	A true fact today will also be a true fact tomorrow.	2.84	2	1.539	0.653	-0.603	Cert
	k04_2F13	There are scientific facts that will never change	3.65	4	1.658	-0.113	-1.256	Cert
	k06_7 [c]	I like teachers who present several different views and let me decide which is best.	4.78	5	1.088	-0.618	-0.087	
	k11_10 [c]	Truth can mean different things to different people.	4.99	5	1.100	-0.995	0.496	
	k13_2F44	There are truths that will always stand	3.87	4	1.562	-0.172	-1.032	
	k14_2F49	Scientific research shows that there is one correct answer to most problems	3.19	3	1.297	0.024	-0.772	
Omniscient authority	k03_3F09	I can believe almost everything I read as part of my studies	4.03	4	1.244	-0.486	-0.258	
	k04_4F04	All experts within a field have the same understanding regarding the basic issues of that field	2.42	2	1.274	0.849	0.285	Cert
	k05_1F15	All teachers will probably arrive at the same answers regarding issues within their field	2.66	2	1.267	0.514	-0.516	
	k09_3F29	I have to accept the answers from a teacher as true	2.63	2	1.359	0.590	-0.469	Auth
	k11_7 [c]	Forming my own ideas about a topic is more important than learning what the textbooks say.	3.97	4	1.268	-0.173	-0.537	
	k12_5F42	Teachers are almost always right	3.15	3	1.227	0.134	-0.348	Auth
	k14_7	I seldom or never question authorities	3.06	3	1.228	0.130	-0.590	Auth
Structure of knowledge	k05_7 [c]	To me, studying means getting the big ideas from the text rather than details.	4.32	5	1.291	-0.575	-0.262	
	k06_8	To be a good student I try to memorize lots of facts.	3.78	4	1.209	-0.119	-0.539	
	k07_8	When I study, I mostly concentrate on specific facts.	3.03	3	1.183	0.471	-0.166	
	k09_7	I like teachers who organize their lectures carefully and then stick to their plan.	4.49	5	1.276	-0.453	-0.533	
	k10_7	It bothers me when a teacher does not say clearly what I am supposed to know in an examination.	4.47	5	1.444	-0.614	-0.646	Struct
	k11_8	It bothers me when teachers do not tell me the answers to complicated problems.	3.97	4	1.466	-0.231	-0.892	Struct
	k11_9	I prefer topics where most problems have only one right answer.	3.58	4	1.382	-0.171	-0.632	Struct
	k12_7 [c]	I try my best to combine information across chapters or even across classes.	4.25	4	1.103	-0.146	-0.641	
	k12_8	Teachers should focus on simple facts instead of complicated theories.	3.45	3	1.377	0.057	-0.686	
	k13_7	I find it annoying to listen to teachers who cannot make their mind up about what they believe.	4.15	4	1.348	-0.221	-0.841	Struct

Original/ hypothesized dimension	Item # [a]	Item label	Mean	Median	Std. Deviation	Skewness	Kurtosis	Original/ novel scales [b]
Learning ability	k09_5F31	Each person needs to learn for her-/himself how she/he learns	5.09	5	1.075	-1.144	0.835	Able
	k11_1F33	A focussed use of learning techniques will lead to better results	4.71	5	1.070	-0.534	-0.293	Able
	k12_9 [c]	Some people are born good learners, others never learn how to learn.	3.99	4	1.503	-0.334	-0.820	
	k13_4F47	It is possible to learn how to learn	4.96	5	1.072	-0.865	0.380	Able
Reflective nature of learning	k08_4F27	When I learn new things it often causes me to question my earlier knowledge	3.76	4	1.324	-0.074	-0.727	
	k09_1F28	When I learn new things I often see my previous knowledge in a new light	4.44	5	1.114	-0.352	-0.499	Constr
	k14_1F48	After thorough consideration I can often see a problem with new eyes	4.30	4	1.093	-0.059	-0.730	Constr
	k14_4F51	New experiences cause me to view knowledge in another way	4.57	5	1.085	-0.527	0.200	Constr
Constructivist approach to learning	k05_4 [c]	My knowledge is an individual matter and it cannot be created together with others	2.48	2	1.314	0.738	-0.232	
	k06_1	The knowledge I already have is like hooks, where I can hang up new pieces of knowledge	4.78	5	1.076	-0.554	-0.442	
	k07_2	Learning is about recognizing patterns and connections between concepts and phenomena	4.61	5	1.091	-0.498	-0.157	Constr
	k07_4	Knowing is not an end state, but an on-going process	5.03	5	1.133	-1.233	1.380	Constr
	k08_6	In order to know more it's important for me to see the connection between things I already know and new things I learn about	4.79	5	1.059	-0.645	-0.206	
	k10_3	It's important to keep track of changes in what I know in order to keep my knowledge up-to-date	4.68	5	1.080	-0.426	-0.661	
	k13_5	If I re-read a textbook chapter, I get a lot more out of it the second time	4.68	5	1.169	-0.774	0.169	
Internet reliance	k07_7	Wikipedia is reliable since it is written by many people with different viewpoints	2.38	2	1.287	0.912	0.157	
	k10_4	Wikipedia is reliable since it is up-to-date	2.31	2	1.253	0.793	-0.112	
	k12_6	I learn things quicker from Internet pages than from books	3.17	3	1.451	0.216	-0.856	Int
	k13_6	Internet sources usually provide me with a clearer picture of subjects than do books	3.36	3	1.428	0.198	-0.765	Int
	k14_5	I can get almost all the information I need to know about a subject from one or two Internet sources	2.68	2	1.270	0.539	-0.417	Int

Original/ hypothesized dimension	Item # [a]	Item label	Mean	Median	Std. Deviation	Skewness	Kurtosis	Original/ novel scales [b]
Connectivist approach to learning	k04_3	When I need to learn about something new, I often ask several friends about their opinion	3.86	4	1.340	-0.228	-0.616	Dia
	k04_6	The more knowledgeable people I know, the more knowledge I have myself	3.54	4	1.565	-0.085	-1.064	
	k05_6	I feel that I learn more when I meet someone new who knows a lot about a field	4.83	5	1.073	-0.733	-0.068	
	k06_5	I build knowledge by developing and maintaining my networks and connections	4.40	4	1.131	-0.306	-0.509	
	k07_6	To learn more I need to keep contact with the people I know	3.62	4	1.293	-0.166	-0.681	
	k08_3	Knowledge may reside also in non-human things like mobile phones, iPods, web services	4.59	5	1.104	-0.604	0.133	
	k08_5	For me, learning is about forming a network of connected information sources	4.18	4	1.129	-0.311	-0.240	
Just-in-time learners	k04_1	Learning is about deciding what I need to memorise and what I can look up somewhere later	3.55	4	1.437	-0.057	-0.766	
	k06_6	If I don't know something it doesn't bother me as long as I know how to learn about it	4.29	4	1.295	-0.521	-0.287	
	k08_1	Knowing where to find knowledge is more important than the piece of knowledge itself	3.51	3	1.472	0.120	-0.925	
	k10_5	Choosing what to learn is the starting point for my learning	4.09	4	1.257	-0.189	-0.583	
	k10_6	Knowledge is not about knowing the answers, but knowing how and where to find the answers	4.21	4	1.292	-0.286	-0.686	
Valuing diversity	k03_5	I create knowledge by interacting with others	4.85	5	1.130	-0.909	0.283	Dia
	k03_7	I like discussing with people who have varying opinions	5.03	5	1.113	-1.197	1.245	Dia
	k04_5	I find it interesting to think about issues that people cannot agree on	4.31	5	1.393	-0.550	-0.517	
	k05_2	The value of knowledge lies in its ability to explain an issue from multiple perspectives	4.93	5	1.078	-0.837	0.090	Constr
	k09_2	Knowledge is about seeing a matter from diverse perspectives, building up the whole	4.64	5	1.019	-0.568	0.156	Constr

Table footnotes

a) The number after 'k' refers to the page number (03-14) in the web questionnaire. The number after 'F' refers to the original FEE numbering.

b) Able - Learning ability; Auth - Omniscient authority; Cert - Certainty of knowledge; Constr - Constructivist approach; Dia - Learning by dialogue; Int - Internet reliance; Struct - Structure of knowledge

c) Item phrasing is reverse compared to other items in the same dimension.

3.1.1 Previously established dimensions

The FEE questionnaire (Moschner et al., 2005) included the original SEQ dimensions *Certainty of knowledge*, *Omniscient authority* and *Learning ability*. Unfortunately, the dimension *Structure* (or *Simplicity) of knowledge* was excluded from the FEE but was included in the 2012 survey being reported here (Table 1).

Justification of knowledge should undoubtedly be a part of the epistemic beliefs dimension set. However, the new students (see section Participants and data collection) that were involved as informants could hardly be expected to possess a sophisticated ontology of the domain they were just entering to study (cf. Greene et al., 2008). Based upon this, upon previously presented considerations (section *Justification for knowing*) and upon the scope of the study, the Justification dimension was omitted at this stage.

3.1.2 Hypothesized dimensions

Out of the five new dimensions suggested in the FEE, only *Reflective nature of knowledge* was used in this study, and the items associated with it were rephrased to reflect ***Reflective nature of learning***. This dimension deals with the learning aspect and was intended to express a reflective stance towards new knowledge.

The debate regarding Digital Natives did not produce an actual definition for Digital Natives but instead, researchers published different descriptions about how the (supposedly) digital generation acted and behaved (cf. Ståhl, 2017). Therefore, the dimensions described below were constructed with a starting point in descriptions regarding attitudes towards knowledge and learning, as reported in various studies. The instrument also set out to test whether the suggested attributes could be identified within this sample.

The descriptions of connectivism (Downes, 2007; Siemens, 2005; 2006, pp. 31, 91) together with Anderson & Balsamo (2008, p. 244) stating that *"They treat their affiliation networks as informal Delphi groups"* have contributed to the items proposed to describe a ***Connectivist approach to learning*** (hereafter the short forms *Connectivist approach* and *Constructivist approach* will be used).

A ***Constructivist approach to learning*** has yet not been suggested in previous instruments, although some items in the dimension *Knowledge Construction and Modification* suggested by Wood & Kardash (2002, p. 250) and the dimension *Reflective nature of knowledge* suggested by Moschner et al. (2005) point in this direction. The writings of Siemens (2006, pp. 6, 20, 31) have also provided input to the items proposed to describe a constructivist approach.

Anderson & Balsamo (2008, p. 244) described the young generation as *"...knowing and being confident where to find information once they need it*". Siemens (2006, p. 31) described deciding what to memorise and choosing what to learn as characteristics in connectivist learning, inspiring the construction of items describing the hypothesized dimension ***Just-in-time learning***.

Reliance on internet is an integral part of the googling mind-set. At the time of planning this research the ISEQ had been introduced (Bråten et al., 2005) but as mentioned above (section *Internet-specific epistemic beliefs*), the ISEQ items focussed exclusively on internet-based information. Thus, the five items concerning internet-based knowledge in the present instrument were generated from literature regarding the so called Digital Natives and the Net Generation (Prensky, 2001; Siemens, 2005; Anderson & Balsamo, 2008), and their preference for internet sources instead of printed sources (cf. Head & Eisenberg, 2010; Purcell et al., 2012, p. 33). The items where phrased to express how the googling mind-set reflects a reliance in that any information you need can always be found on internet and accordingly, the dimension was labelled ***Internet reliance***.

Siemens (2006, pp. 16, 31, 56, 117) described ***Valuing diversity*** as a central trait in connectivism, which requires interaction (Downes, 2007, p. 78) and also involves exposing oneself to and valuing different opinions, all contributing to the individual learning process. This trait, requiring *"... the widest possible spectrum of points of view..."* (Siemens, 2006, p. 16), can be regarded an expression for both a general scholarly approach and also the epistemic development from realist over absolutist and multiplist to evaluativist understanding (Kuhn & Weinstock, 2002, p. 124).

The present instrument includes four previously described and six hypothesized dimensions, altogether 60 items (Table 1).

3.2 Participants and data collection

The study was part of a university development project with the objective of collecting information about the new students' mind-sets to develop teaching and learning practices. The university's Board on Ethics approved the project research plan, including procedures for data collection, analysis and reporting.

Data were collected among all new students in August 2011 and 2012 (N = 476/440). Since epistemic beliefs can change through intervention (cf. Kienhues et al., 2008), it was crucial to get a "snapshot" of the students' epistemic beliefs by collecting data during the very first week of the semester, before the students were exposed to study subjects or pedagogical influences at the university. Data collection was organised during compulsory and scheduled ICT Level Test sessions, where students first completed another survey called 'ICT, media and me', then the compulsory ICT Driving License Level Tests and finally the survey 'Me and my knowledge'.

Figure 1. On-line questionnaire screenshot.

The students were introduced to the objectives of the project, and informed orally and in writing that although the ICT level tests were compulsory, the surveys were voluntary and did not include any financial or other incentives. Due to the survey being an operationalization of the university's statutory obligation to continuously develop its education, informed consent was registered following a simplified procedure. The students were informed that by (performing the action of) filling in the questionnaire, they express their consent for the data being used for the purposes described in the information sheet and in the Description of the Scientific Research Data File as required in the legislation concerning personal data in research (Personal Data Act, 1999). Accordingly, the students had the opportunity to withdraw their permission by contacting the researcher by a given date, after which the data set was anonymized. The students were also introduced into the functionality of the questionnaires and informed that support was provided if needed.

The survey was presented in an on-line questionnaire using a 6-point Likert-type response format (Figure 1). When applying the 63-item SEQ, Wood & Kardash (2002, p. 244) received student comments indicating respondents' difficulties in understanding certain items. Although some researchers (e.g. Martin, 2005, p. 728) discourage the use of 'don't know' options, the scale in this questionnaire was supplemented

with two non-substantial options, 'don't know' and 'don't understand'. This is partly supported by Muis et al. (2006, p. 25), noting that it has not been empirically studied what individuals actually think as they fill out questionnaires. Providing both options was especially important when introducing new items, since these options provided information regarding comprehensibility, potentially valuable when considering items to exclude (cf. Finch, Immekus, & French, 2016, p. 144). Further, the non-substantial options were placed on both sides of the substantial options in order not to distort the visual midpoint of the Likert-type response format (cf. Tourangeau, Couper, & Conrad, 2004).

In survey presentation, it was necessary to prevent fatigue effect and satisficing (cf. Cape, 2010), and any effect where question context or order might influence question interpretation (cf. Martin, 2005, p. 726; Tourangeau et al., 2004). Therefore, a progress indicator was included and the items were distributed over twelve pages containing four to six items each, which also improved readability. Further, to prevent inter-item influence, each subscale's items were distributed over different pages (e.g. the page in Figure 1 containing items from five subscales) and the survey service was set to randomise item order within each page.

3.3 Research data and sample characteristics

The present study is based on data collected in 2012, where 371 students chose to complete the survey 'Me and my knowledge'. Only those cases containing substantial responses to more than 70% of the items where retained for further analyses (n = 348). The 23 excluded cases had responded only to first-page items and were therefore regarded as dropouts. The complete data set with 371 cases exhibited missing values increasing from 4.2% up to 11.7% on page level, whereas this trend in the 348-case subsample developed from 2.5% to 7.0%. This, together with the dropouts, indicates that most respondents who started the survey also completed it, and that an actual fatigue effect was avoided. On item level, the portion of missing values ranged from 1.4% to 10.1%, where the two *Certainty of knowledge* items k13_2F44 and k14_2F49 (Table 1) showed the highest portions of missing values, mostly 'don't know' responses. The highest 'don't understand' portions occurred for three items representing the dimensions *Just-in-time learning* (k04_1), *Constructivist approach* (k07_2) and *Connectivist approach* (k08_5).

Since the questionnaire applied a Likert-type response format producing data on an ordinal scale, it is not meaningful to analyse distribution or assess normality on item level (cf. Carifio & Perla, 2007) but instead, analysis of the actual scales is postponed to the discussion section. For those calling for an item level analysis it can be mentioned that for each item, the response value ranged over the whole scale (1..6). The items showed a standard deviation between 1.02 and 1.66, a skewness between -1.23 and 0.91 and a kurtosis between -1.26 and 1.38. The criterion of the skewness and kurtosis value being within the range ±1 was met regarding 57 and 55 items, respectively. The Shapiro-Wilks test suggested non-normal distribution, whereas the Kolmogorov-Smirnov test suggested normal distribution throughout all items. A visual inspection of histograms, normal Q-Q plots and box plots showed that the items were approximately normally distributed. For the items showing skewness or kurtosis outside the ±1 range, the deviation was minor and further, the sample size was large enough to reduce a possible detrimental effect (cf. Hair, Black, Babin, & Anderson, 2010). Based on the aforementioned criteria, the items were considered as normally distributed.

The current 348-case subsample holds students from twelve degree programmes, both domestic and international students (86.8% / 13.2%), and a gender distribution holding 66% female students. The age average was 21.7 with 91% being born in 1986-1995. For this study, sample demographics should be reviewed in relation to access to internet resources.

Internet and publicly available search engines were launched already in the mid 1990'ies and during the following ten years, search engine use was established (http://www.searchenginehistory.com/). 2011-2012 were the very years when internet services, previously available via computers, became truly ubiquitous due to 3G/4G-connected smartphones becoming everyday tools, and Finnish net operators offering affordable 3G/4G-subscriptions including generous mobile data. The mobile phone prevalence within both cohorts was close to 100%. Smartphone as a concept was not yet established and thus, the corresponding survey item was phrased "My mobile phone is connected to the internet". From 2011 to 2012, the portion of users across the

cohorts having an internet-connected phone increased among domestic students from 48.7 to 81.3% and among international students from 60.7 to 90.6%, within the total cohorts from 50.2 to 82.5%. This corresponds well with the national statistics, according to which 53% of those aged 16-24 had a smartphone in the spring of 2011 (OSF, 2011). At the time of data collection, the respondents had been exposed to computers, mobile phones and internet for in average 12, 10 and 9 years respectively. To conclude, the sample can be regarded a rather typical Net Generation cohort.

3.4 Analysis methods

Fabrigar, Wegener, MacCallum, & Strahan (1999) argue that Principal Component analysis is not a true method of factor analysis. They recommend the use of Maximum Likelihood, as later supported by Osborne (2014, p. 9) and Finch et al. (2016, p. 131). Thus, the analysis procedure starts with an EFA with ML as extraction method, followed by a validation procedure including EFA and CFA on split halves of the sample (Fabrigar et al., 1999; Fokkema & Greiff, 2017; Knight et al., 2017; Leal-Soto & Ferrer-Urbina, 2017; Osborne, 2014, pp. 6, 119-120; Tang, 2010). For all statistical tests, a significance level of .05 was used and in EFA and CFA procedures, the absolute loading value .32 was used as the threshold when assessing item (non-)loadings and cross-loadings (cf. Finch et al., 2016, p. 143). In table and diagram presentations, loadings <.32 are generally not displayed although during EFA procedures, low loadings were not suppressed since that may cause loss of valuable information (such as item k14_5, Table 3). The SPSS software package (SPSS, 2016b) was used for EFA procedures, and the CFA procedures were performed using the Amos software package (SPSS, 2016a).

To build analysis on true data, missing data values were not imputed, since any kind of replaced or imputed values are, after all, only estimates. This choice was made at the cost of listwise deletion reducing the number of cases in EFA, and missing values thwarting the use of modification indices to support refinement in CFA.

4 Results

In this section, the results are presented together with analyses, since some results inform the subsequent steps. The reasoning behind e.g. item disposal, number of factors and factor labelling will be presented in conjunction with EFA on the complete item set.

4.1 Original and hypothesized dimensions of epistemic beliefs

4.1.1 Replicating original dimensions

For replication purposes, EFA was first performed on the 27 items associated with the original dimensions. Dysfunctional items (zero, low and cross-loading) were stepwise discarded (cf. Finch et al., 2016, pp. 143-144). A model based on 18 items showed good fit indices and was interpreted as a successful replication (despite ML extraction and Promax rotation).

4.1.2 Emerging dimensions

The 60-item questionnaire contained 33 items that were associated with six hypothesized dimensions: *Reflective nature of learning, Connectivist approach, Just-in-time learning, Constructivist approach, Internet reliance* and *Valuing diversity* (Table 1). Seeking inspiration from Bråten et al. (2005) and Trautwein & Lüdtke (2007) who analysed only one or two factors, this item subset was initially factor analysed separately in order to identify dysfunctional items.

The EFA on the hypothesized dimensions was truly exploratory, including different rotation methods, varying the number of extracted factors and stepwise reduction of dysfunctional items (Finch et al., 2016, pp. 143-144; Osborne, 2014, pp. 17, 30-33). Using ML, Promax rotation and Listwise deletion, the EFA resulted in a four-factor model based on 23 items (n=191). The model showed good fit indices (Eigenvalues 6.35 .. 1.5, 51% of variance explained; KMO=.864, Bartlett's Chi-Square=1397, df=253, Sig.<.000, Goodness-of-fit Test Chi-Square=182.7, df=167, Sig.=.192) and reflected three of the hypothesized dimensions: *Constructivist approach*, *Connectivist approach*, *Internet reliance* and a fourth one, now labelled *Learning by dialogue*. Each item loaded strongly on one factor without cross-loadings. Throughout the various models, *Constructivist approach* and *Connectivist approach* correlated strongly, and several of the other factors correlated weakly with each other (Table 2).

Table 2

Factor correlation matrix, four-factor model based on 23 new items

Inter-factor correlations	Constructivist approach	Connectivist approach	Internet reliance	Learning by dialogue
Constructivist approach		**.516**	.067	.269
Connectivist approach	**.516**		.287	.194
Internet reliance	.067	.287		.030
Learning by dialogue	.269	.194	.030	

4.1.3 An extended set of dimensions

Since inter-factor correlation occurred in all the previous analyses, EFA on the complete item set were performed using ML extraction and Promax or Oblimin as oblique rotation methods (cf. Finch et al., 2016, p. 133; Knight et al., 2017; Osborne, 2014, pp. 30-33; Strømsø & Bråten, 2010). The model was stepwise refined by removing low-loading and cross-loading items while simultaneously assessing their conceptual relevance, their communality estimates and their internal consistency within the anticipated scale. During the process, the six reversely phrased items occurring in four dimensions (Table 1) were discarded due to dysfunctionality. Thus, within all the hypothesized dimensions, the items were unidirectional.

The refinement procedure boiled down to a model with seven factors and 26 items that fit the data reasonably well (Table 3). Both original and hypothesized dimensions appeared distinctly without cross-loadings (except for items k10_7 and k14_5), each dimension loaded on at least 3 items, and 25 out of 26 items loaded (>.32) on the anticipated factor.

Table 3

The proposed EFA model based on 26 items

Item #	Item label	Constructivist approach	Omniscient authority	Internet reliance	Structure of knowledge	Learning by dialogue	Certainty of knowledge	Learning ability
k14_1F48	After thorough consideration, I can often see a problem with new eyes	.822						
k14_4F51	New experiences cause me to view knowledge in another way	.628						
k09_2	Knowledge is about seeing a matter from diverse perspectives, building up the whole	.546						
k09_1F28	When I learn new things I often see my previous knowledge in a new light	.446						
k07_2	Learning is about recognizing patterns and connections between concepts and phenomena	.382						
k07_4	Knowing is not an end state, but an on-going process	.341						
k05_2	The value of knowledge lies in its ability to explain an issue from multiple perspectives	.323						
k09_3F29	I have to accept the answers from a teacher as true		.822					
k12_5F42	Teachers are almost always right		.520					
k14_7	I seldom or never question authorities		.475					
k12_6	I learn things quicker from Internet pages than from books			.888				
k13_6	Internet sources usually provide me with a clearer picture of subjects than do books			.719				
k14_5	I can get almost all the information I need to know about a subject from one or two Internet sources			(.30)	(.25)		(.23)	
k11_8	It bothers me when teachers do not tell me the answers to complicated problems				.699			
k13_7	I find it annoying to listen to teachers who cannot make their mind up about what they believe				.557			
k10_7	It bothers me when a teacher does not say clearly what I am supposed to know in an examination	.364			.537			
k11_9	I prefer topics where most problems have only one right answer				.448			
k03_5	I create knowledge by interacting with others					.753		
k03_7	I like discussing with people who have varying opinions					.519		
k04_3	When I need to learn about something new, I often ask several friends about their opinion					.405		
k03_8	A true fact today will also be a true fact tomorrow						.613	
k04_2F13	There are scientific facts that will never change						.587	
k04_4F04	All experts within a field have the same understanding regarding the basic issues of that field						.424 a)	
k09_5F31	Each person needs to learn for her-/himself how she/he learns							.723
k13_4F47	It is possible to learn how to learn							.557
k11_1F33	A focussed use of learning techniques will lead to better results							.464

Factor Correlation Matrix	Constr. approach	Omnisc. authority	Internet reliance	Structure of knowl.	Learning by dial.	Certainty of knowl.	Learning ability
Constructivist approach		.031	-.021	.115	.282	-.023	.506
Omniscient authority	.031		.081	.319	-.062	.376	.030
Internet reliance	-.021	.081		.143	-.026	.143	-.110
Structure of knowledge	.115	**.319**	.143		-.010	.221	.205
Learning by dialogue	.282	-.062	-.026	-.010		-.075	.195
Certainty of knowledge	-.023	**.376**	.143	.221	-.075		-.005
Learning ability	**.506**	.030	-.110	.205	.195	-.005	

Table footnotes
ML, Promax rotation converged in 16 iterations; Listwise deletion, n=195, Eigenvalues 4.85 .. 1.01, 59.3% of variance explained; KMO=.782, Bartlett's Chi-Square=1468, df=325, Sig. <.000, Goodness-of-fit Test Chi-Square=169.8, df=164, Sig.=.361
a) Item loading not consistent with hypothesized dimension but conceptually coherent.

From this model, several items were dropped due to loading weakly or inconsistently with the hypothesized dimension. The retained original items loaded on the same factors as in the EQ, except for item k04_4F04 that was originally associated with *Omniscient authority*. The current loading on *Certainty of knowledge* can be regarded as conceptually coherent.

The issues regarding which items to discard, how to decide on the number of factors, and how to label the subscales require some comments. As Osborne (2014, pp. 17-18) notes, EFA is a low-stakes procedure and expressly exploratory. Accordingly, I entered the process with 60 items, a hypothesized underlying conceptual model, and used the statistical package (SPSS, 2016b) to provide suggestions for a factor model. During EFA iterations, the dysfunctional items were eventually revealed and discarded. Besides varying extraction and rotation, the search for an adequate number of factors included extracting factor sets ranging from two factors below up to two factors above the number suggested by the scree plot elbow (Osborne, 2014, p. 18). This method provided valuable information: increasing the number of factors caused related items to split over several factors, whereas reducing factors caused items to pile up on one factor, usually then holding items from dimensions that at the end turned out to correlate. Thus, the search for a factor model included weighing of theory, scree plot, item loadings and communalities, eigenvalues, internal consistencies and conceptual considerations.

During the EFA iterations, the hypothesized dimensions did not turn out quite as anticipated, which is only part of the nature in explorative work (cf. Osborne, 2014, p. 17). In most of the explored models, the five hypothesized dimensions boiled down to three (Table 3). The dimension *Learning by dialogue* holds items from the suggested dimensions *Valuing diversity* and *Connectivist approach*, whereas the dimension *Constructivist approach* besides its own items also holds items from the hypothesized dimensions *Valuing diversity* and *Reflective nature of learning*. All the three items originally associated to *Internet reliance* consistently loaded on that dimension (Table 1).

Retaining the items k14_5 and k10_7 violates the rule of using only strong, single-loading items and requires commenting. The internal consistency test showed that deleting the item k14_5 entailed a slightly improved alpha value, but at the cost of reducing the factor *Internet reliance* to only two items. Further, since the item communality value was reasonably good, the connection to *Structure of knowledge* occurred also in the path diagram, and the CFA indicated that discarding the item impaired fit indices, there was enough support for retaining the item.

As expected, the item k10_7 loaded strongly on the *Structure of knowledge* dimension, but surprisingly also on *Constructivist approach*. The item was retained since discarding it would have impaired the *Structure of knowledge* internal consistency considerably. The split half EFA suggested single-loading on *Structure of knowledge*, whereas the CFA suggested a connection to *Constructivist approach* and indicated that discarding the item impaired fit indices.

Three of the original dimensions (except *Learning ability*) correlated weakly with each other. Further, *Constructivist approach* correlated strongly (.506) with *Learning ability* and weakly (.282) with *Learning by dialogue*.

4.2 Evaluating the extended instrument

For the purpose of evaluating the stability of the model presented in Table 3, the data set was randomly split into two equal halves A and B, that were subject to EFA and CFA, respectively (cf. Fokkema & Greiff, 2017, p. 401).

4.2.1 Exploratory split half

An EFA was performed with 26 items on the split half A using the same methods as in the initial model. The model arrived at (Table 4) did not show a one-to-one correspondence to the initial model (Table 3) but resembled it strongly, with 22 out of 26 items loading as anticipated. All the hypothesized dimensions were reflected in the seven factors, although two of the *Constructivist approach* items loaded on the *Learning ability* factor (a). Further, two items loaded on unexpected factors (b), and the *Learning by dialogue* item k03_5 caused a Heywood case. Still, the fit indices suggested that the proposed model, appearing almost similar in both Oblimin and Promax rotation, fit also the split data set fairly well.

Table 4

Exploratory Factor Analysis on split half A

Item #	Item label	Learning by dialogue	Constructivist approach	Internet reliance	Omniscient authority	Structure of knowledge	Learning ability	Certainty of knowledge
k03_5	I create knowledge by interacting with others	1.046						
k03_7	I like discussing with people who have varying opinions	.306						
k14_1F48	After thorough consideration, I can often see a problem with new eyes		.889					
k14_4F51	New experiences cause me to view knowledge in another way		.653					
k09_2	Knowledge is about seeing a matter from diverse perspectives, building up the whole		.618					
k07_4	Knowing is not an end state, but an on-going process		.451					
k09_1F28	When I learn new things I often see my previous knowledge in a new light		.369					
k12_6	I learn things quicker from Internet pages than from books			.914				
k13_6	Internet sources usually provide me with a clearer picture of subjects than do books			.703				
k09_3F29	I have to accept the answers from a teacher as true				.751			
k12_5F42	Teachers are almost always right				.640			
k14_7	I seldom or never question authorities				.467			
k04_3	When I need to learn about something new, I often ask several friends about their opinion	(.217)			.334 b)			
k10_7	It bothers me when a teacher does not say clearly what I am supposed to know in an examination					-.693		
k11_8	It bothers me when teachers do not tell me the answers to complicated problems					-.632		
k13_7	I find it annoying to listen to teachers who cannot make their mind up about what they believe					-.584		
k11_9	I prefer topics where most problems have only one right answer					-.436		(.320)
k09_5F31	Each person needs to learn for her-/himself how she/he learns						.755	
k11_1F33	A focussed use of learning techniques will lead to better results						.649	
k07_2	Learning is about recognizing patterns and connections between concepts and phenomena						.402 a)	
k13_4F47	It is possible to learn how to learn						.358	
k05_2	The value of knowledge lies in its ability to explain an issue from multiple perspectives						.337 a)	
k03_8	A true fact today will also be a true fact tomorrow							.575
k04_4F04	All experts within a field have the same understanding regarding the basic issues of that field							.573
k04_2F13	There are scientific facts that will never change							.454
k14_5	I can get almost all the information I need to know about a subject from one or two Internet sources			(.229)				.448 b)

Factor Correlation Matrix	Learning by dial.	Constr. approach	Internet reliance	Omnisc. authority	Structure of knowl.	Learning ability	Certainty of knowl.
Learning by dialogue		.210	-.051	-.010	.267	.169	-.147
Constructivist approach	.210		.048	.010	-.152	.494	-.054
Internet reliance	-.051	.048		.076	-.140	-.059	.157
Omniscient authority	-.010	.010	.076		-.259	.131	.363
Structure of knowledge	.267	-.152	-.140	-.259		-.208	-.126
Learning ability	.169	**.494**	-.059	.131	-.208		-.063
Certainty of knowledge	-.147	-.054	.157	**.363**	-.126	-.063	

Table footnotes
a) Item loading not consistent with hypothesized dimension but conceptually coherent
b) Item loading not consistent with hypothesized dimension, vague conceptual coherence
ML, Oblimin rotation converged in 12 iterations; Listwise deletion n=96, Eigenvalues 5.00 .. 1.06, 62.9% of variance explained; KMO=.706; Bartlett's Chi-Square=928, df=325, Sig. <.000; Goodness-of-fit Test Chi-Square=179.5, df=164, Sig.=.193

As in the initial model, the *Constructivist approach* factor correlated strongly with the *Learning ability* factor (.494) and *Omniscient authority* correlated with *Certainty of knowledge* (.363).

4.2.2 Confirmatory split half

CFA was performed on the same 26 items as the previous EFA but on the split half B (n=174) of the data set. In the first step, conceptually irrelevant and low connections between latent variables were removed, which resulted in an initial model with partly insufficient fit indices. Assessing model fit and choice of cut-off criteria (in brackets) follow the recommendations by Schreiber, Nora, Stage, Barlow, & King (2006) and Hooper, Coughlan, & Mullen (2008).

Since the data set contained empty cells, it was not possible to utilize the feature where the Amos software would provide suggestions for modification (SPSS, 2016a). Instead, model refinement was performed manually, partly following loadings and correlations indicated in the previous EFA models (Tables 3 and 4), and partly by adding and removing connections based on conceptual considerations in an exploratory manner. Thus, some connections between latent variables, although weak, were retained, under the condition that they were conceptually defensible and contributed to improving fit indices. Then again, in some cases conceptually defensible connections had to be discarded if their loading value was low (mainly <.32) and retaining them impaired the fit indices. The procedure resulted in a conceptually defensible path diagram (Figure 2), similar to the EFA models (Tables 3 and 4) and reasonable although not perfect fit indices (Chi-square/df=1.504, RMSEA=.054, TLI=.821, CFI=.853, PCLOSE=.260). The item k13_6 caused a minor Heywood case (1.01), which was accepted since any attempt to manipulate constraints impaired fit indices.

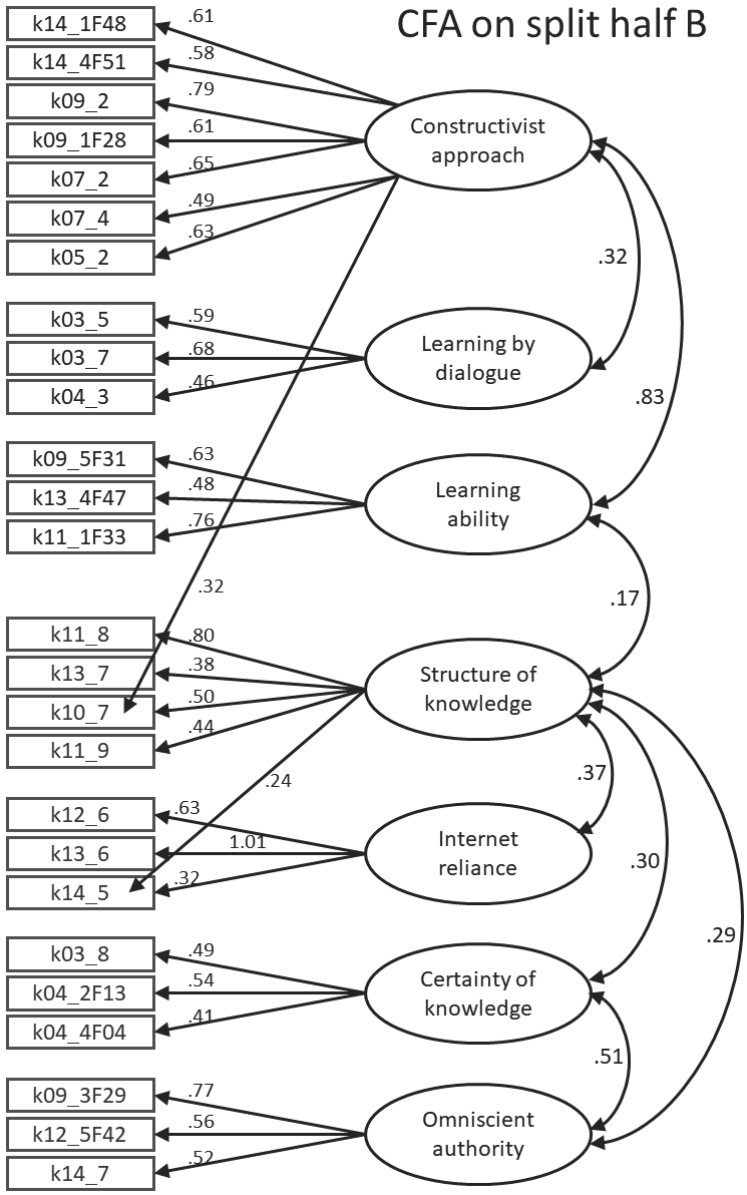

Figure 2. Simplified CFA path diagram based on 26 items and split half B data set (cut-off criteria in brackets). Chi-square/df=1.504 (<2), RMSEA=.54 (<.60), TLI=.821 (≥.95), CFI=.853 (≥.95), PCLOSE=.260 (≥.05).

5 Discussion

5.1 Construct validity

After the seven dimensions had been identified (Table 3), they appeared stable throughout the succeeding analyses. In some cases, items associated with the dimensions *Constructivist approach* and *Learning ability* cross-loaded. This phenomenon is conceptually coherent considering the strong correlation between these factors that, in turn, is possibly due to a latent second-level variable. The internal replications by exploratory and confirmatory factor analyses on randomized split halves provide information speaking in favour of the proposed factor model.

Since the suggested construct holds good or reasonable fit indices and behaves in a consistent manner throughout the different analyses, it can be regarded as holding initial construct validity. Initial meaning here that the present study was only a first attempt to launch the hypothesized dimensions, and further research (with new data and adjusted items) is still required to test the generalizability of the construct (Finch et al., 2016, pp. 127-128). Further testing should also involve a diverse student population with regards to domains and cultural background.

5.2 Content validity

In general, the factors reflect both original and hypothesized dimensions. In all EFA models (Tables 3 and 4) as well as in the CFA path diagram (Figure 2), the highest loading on each factor occurred on one of the anticipated items. Regarding the original dimensions, it turned out that 12 out of the 27 items reflected the anticipated construct and one item loaded differently than in previous studies (see rightmost column in Table 1). Within the hypothesized scales, 13 items where included in the novel scales.

To answer the question if and to which extent the factors actually describe the dimensions, this section presents comments regarding each dimension in the model (Table 3, Figure 2). The original dimensions retained their original labels, and the labelling of the novel dimensions is commented in section *Novel dimensions*. Choices regarding factor model and number of factors were discussed in section *An extended set of dimensions*.

5.2.1 Original dimensions

Learning ability

Three of the four items in the *Learning ability* dimension proved stable across most analyses and models, whereas the item k12_9 was dropped at an early stage. In some EFA models, this factor attracted items from the *Constructivist approach* dimension, which is consistent with the strong correlation between these dimensions (Table 3, Figure 2).

Omniscient authority

In her earliest studies, Schommer (1990; 1998) reported this dimension as difficult to capture, whereas Schraw et al. (2002, p. 267) and Moschner et al. (2005) were able to identify this dimension. In this sample, the authority dimension manifested clearly in all models, and the items k09_3F29, k12_5F42 and k14_7 loaded consistently on the *Omniscient authority* factor.

Structure of knowledge

Throughout the analyses, most of the *Structure of knowledge* items loaded as expected. Item k12_7 often loaded on the *Learning ability* factor but for this item, a connection to learning is not far-fetched; combining information across sources may express an active stance towards learning, rather than a view of the *Structure of knowledge*. Thus, this item may be an example of a phrasing containing something that might be

called keyword shifting, where the keyword *"combining"* is perceived differently: some respondents recognize the active learning approach, whereas other see it as an expression for knowledge as bits and pieces that can be combined or kept isolated.

During the refinement process, item k12_7 as well as several other items were discarded, leaving four items to represent this dimension. Looking at the discarded vs. retained items (Table 1) does, however, raise some questions. It seems unfortunate to discard the items k05_7, k06_8, k07_8 and k12_7, since they indeed express a knowledge aspect, i.e. a very clear stance regarding the *Structure of knowledge* as isolated facts vs. information that can or should be combined into larger entities. Then again, the retained items seem to focus very much on the actions and behaviour from part of the teacher, almost like introducing a teaching aspect to epistemic beliefs, besides the knowledge and learning aspects. Interestingly, five out of the six discarded items (k05_7, k06_8, k07_8, k09_7 and k12_7) stem from the original EQ.

Certainty of knowledge

In most models, items k03_8, k04_2F13 and k13_2F44 loaded as expected on the *Certainty of knowledge* factor, but often accompanied by items k04_4F04 and k05_1F15, originally associated with *Omniscient authority*.

The items k04_4F04 and k05_1F15 (discarded) may be examples of items with keyword shifting of another kind. Here, the respondent may pay attention either to the "experts/ teachers" as authorities, or rather focus on "same answers / same understanding", the latter option connecting more to knowledge being certain. This observation shows similarity to the EQ subset *Avoid ambiguity* loading on *Simple (Structure of) knowledge* instead of *Certain knowledge* (cf. Schommer, 1990; Wood & Kardash, 2002, p. 241). It should be mentioned that the discarded items k13_2F44 and k14_2F49 were the ones to show the highest 'don't know' portions.

5.2.2 Novel dimensions

Out of the six hypothesized dimensions, three survived the EFA and CFA iterations. *Constructivist approach* and *Internet reliance* were retained and *Learning by dialogue* was introduced as the third dimension. The crucial question is, whether the novel dimensions are defensible. Do they reflect the constructs, and are the constructs relevant and credible?

Constructivist approach to learning

The novel dimension *Constructivist approach to learning* did not turn out as anticipated but instead, in the proposed model it holds items also from the hypothesized dimensions *Valuing diversity* and *Reflective nature of learning* (Table 1). Most of the seven items loading on this factor in the initial model (Table 3) proved stable throughout the different analyses. In the split half EFA, the items k05_2 and k07_2 loaded on *Learning ability*, which is both conceptually coherent as well as understandable considering the strong correlation between these dimensions.

To some extent, the *Constructivist approach* can be regarded as an antithesis to *Omniscient authority*; a naïve stance on the *Omniscient authority* dimension would entail a belief that knowledge is handed down by some authority, which implicitly would exclude the possibility of the individual constructing knowledge herself. However, if these dimensions were opposite to each other, they would also correlate negatively, which was not the case.

The explanation may lie therein that the items that were used to operationalize the *Omniscient authority* dimension mainly focus on how the respondent relates to authorities and to the knowledge handed down by them. The items do not actually provide information about to which extent the respondent thinks it is possible to construct knowledge. Thus, the *Constructivist approach* dimension can rather be regarded as a supplement to the *Omniscient authority* dimension and furthermore, whereas the *Omniscient authority*

dimension expresses a knowledge (source) aspect, the *Constructivist approach* dimension expresses a learning (as construction) aspect.

Learning by dialogue

In the initial EFA (Table 3), this dimension contained items from the hypothesized dimensions *Valuing diversity* (k03_5, k03_7) and *Connectivist approach* (k04_3), all with strong loadings. In the EFA on split half A, the item k03_5 caused a Heywood case while both other items loaded weakly and moreover, k04_3 loaded on the *Omniscient authority* factor, which is conceptually questionable (Table 4). The CFA path diagram on split half B (Figure 2) shows rather weak loadings on this latent variable, but the correlation with *Constructivist approach* is strong, which is conceptually coherent. The discarded items, especially k04_5 and k08_5, that were suggested to describe *Connectivist approach* and *Valuing diversity*, might still be worth testing after rephrasing.

Despite some instability, probably due to low number of cases in the split halves, this dimension can still be defended since it expresses an aspect not expressed in the previous dimensions, namely learning as a social process where the interaction with others, also those representing divergent opinions, is central.

Internet reliance

Internet reliance contains three of the five items originally associated to this dimension. Some items associated to *Just-in-time learning* might have been associated to this dimension but were discarded due to instability.

The items k12_6 and k13_6 proved stable across the analyses, whereas k14_5 loaded weakly and cross-loaded in the initial model and loaded on *Certainty of knowledge* in the split half EFA. In the split half CFA, k13_6 caused a Heywood case and k14_5 loaded weakly on this dimension. Adding a connection from *Structure of knowledge* to k14_5 improved fit indices. The corresponding loading also occurred in the initial EFA model (Table 3).

The fact that ISEQ items (Bråten et al., 2005) were not included to a larger extent may be surprising. However, a closer look shows that the three items included in the present instrument resemble the ISEQ General Internet Epistemology items strongly, and basically cover the same topics.

The items in this dimension were presented from a naïve perspective and were slightly skewed to the right, indicating that the respondents were not quite as convinced of internet as the Digital Natives debate may have suggested.

5.3 Correlating dimensions

The question whether the dimensions correlate or not has been an issue throughout the years within this line of investigation. In her first studies, Schommer (1990; 1998) used only Varimax rotation and apparently assumed non-correlating dimensions. One might ask if the idea of a set of *"more or less independent dimensions"* (Schommer, 1990) has created an expectation of the dimensions being uncorrelated?

Schraw et al. (2002, p. 265) analysed their material using both orthogonal and oblique rotation, but concluded that the factors did not correlate. Still, their Principal Component Analyses with Varimax rotation revealed a weak positive correlation between the *Omniscient authority* and *Simplicity/Structure of knowledge* dimensions (p. 269). Then again, Wood & Kardash (2002, p. 252) found moderate to strong inter-factor correlations using factor analysis. Wood & Kardash (2002, p. 239) also discourage from limiting exploration to orthogonal rotation methods, since forcing inter-correlated factors into an orthogonal model will cause items to cross-load, and the attempt to find a simple structure will fail. Otting et al. (2010) identified a relation between Expert knowledge (cf. *Omniscient authority*), *Certainty of knowledge* and traditional conceptions of teaching and learning. Accordingly, they also identified a relation between Learning effort (cf. *Learning ability*) and constructivist conceptions of teaching and learning (cf. the *Constructivist approach* identified in the present study).

Thus, since the first explorations in the present study indicated that at least some factors correlate, it was obvious that oblique rotation methods should be used (cf. Finch et al., 2016, pp. 133, 142; Osborne, 2014, pp. 30-33) to allow the factors to correlate, and as it turned out, they did. Throughout the analyses (Tables 2, 3, 4 and Figure 2), the naïvely oriented original dimensions *Omniscient authority*, *Structure of knowledge* and *Certainty of knowledge* correlated with each other. This is in line with the findings by Bråten et al. who merged these dimensions into a factor labelled *General Internet Epistemology*, but also raises the question if the *General Internet Epistemology* factor (Bråten et al., 2005; Knight et al., 2017) actually suggests a second-level latent variable?

Across the novel dimensions, correlations occurred between *Learning by dialogue* and *Constructivist approach*, although surprisingly weak. Then again, *Constructivist approach* always correlated strongly to *Learning ability*, which was also confirmed in CFA (Figure 2). The *Internet reliance* dimension correlated weakly with *Certainty of knowledge* and *Structure of knowledge* (in CFA only with the latter) which may seem surprising but still coherent when taking a closer look at the single items. Believing that you can get almost all information about a subject by googling one or two internet sources, and that they can provide you with a clearer picture (than books), will probably go hand in hand with a belief in knowledge being certain and structured. The overall weak correlations to *Internet reliance* may also suggest that this dimension develops "more or less independently" as Schommer (1990) originally suggested.

The strong correlation between *Constructivist approach* and *Learning ability* is coherent, since believing in everyone's ability to learn how to learn is part of the constructivist view where the metacognitive component, the learner's awareness of her/his own learning, is central. The correlation between *Constructivist approach* and *Learning by dialogue* is also coherent. The *Constructivist approach* regards learning as a process of reasoning and construction, where meaning and interpretation is often negotiated in social settings, in dialogue with other learners, and learning is enriched by multiple views and perspectives. The correlation is lower than anticipated, which may be due to *Learning by dialogue* being represented by only three items.

To conclude, limiting the EFA to orthogonal rotation methods would have concealed the inter-factor relations reported here and perhaps also forced the items to load on inappropriate factors (cf. Osborne, 2014, pp. 30-33).

5.4 Methodological considerations

5.4.1 Scale considerations

Data and sample have been partly described in the section Research data and sample characteristics. Due to elimination of cases with a high portion of non-response, the items used for analysis contained between 91.7 and 98.6% substantial responses. Since the purpose was to form subscales, it is appropriate to inspect the characteristics and normality of the subscales (cf. Carifio & Perla, 2007).

Table 5

Comparison of subscale item means, number of items and subscale internal consistencies in FEE (Moschner et al., 2005), in hypothesized and in proposed model subscales

Orien-tation		FEE		Hypothesized subscales [a]		Novel subscales	
	Subscale	Means	Items (alpha)	Means	Items (alpha)	Means	Items (alpha)
Naïve	Certainty of knowledge	3.72	7 (.78)	3.39	4 (.63)	2.97	3 (.54) [b]
	Omniscient authority	2.33	6 (.71)	2.99	6 (.73)	2.95	3 (.67)
	Structure of knowledge			3.87	8 (.74)	4.04	4 (.63)
	Just-in-time learners			3.93	5 (.63)		
	Internet reliance			2.78	5 (.75)	3.07	3 (.70)
Sophisticated	Learning ability	4.49	4 (.73)	4.69	4 (.56)	4.92	3 (.64)
	Constructivist approach			4.76	6 (.79)	4.65	7 (.83) [c]
	Reflective nature of learning	4.94	5 (.79)	4.27	4 (.73)		
	Connectivist approach			4.15	7 (.71)		
	Valuing diversity			4.75	5 (.64)		
	Learning by dialogue					4.58	3 (.50) [d]

Table footnotes
a) Means and alpha values are calculated excluding six items with reverse phrasing, cf. Table 1
b) Containing one item also from Omniscient authority
c) Containing items also from Reflective nature of learning and Valuing diversity
d) Containing items from Connectivist networking and Valuing diversity

The internal consistencies were analysed both for the hypothesized subscales (54 unidirectional items, Table 1) and for the proposed model subscales (26 items, Table 3). As illustrated in Table 5, the subscales showed large variations; for two of the novel dimensions, the internal consistency index was acceptable. However, for the subscales *Certainty of knowledge* and *Learning by dialogue*, the alpha values were disappointingly low, although not necessarily poor compared to earlier studies (e.g. Schommer, 1993; Schraw et al., 2002, pp. 266-267; Wood & Kardash, 2002, p. 253). However, as Wood & Kardash (2002, p. 237) point out, a low internal consistency value should not too hastily be taken as a motive to discard a subscale. Rather, a low value should encourage increasing the number of items and developing them such that they can more precisely express the respondent's stance on a specific matter. Further, as Osborne (2014, p. 105) notes, the alpha values (Table 5) rather express properties of the sample than properties of the instrument.

Carifio & Perla (2007) recommend 6-8 items for each factor in EFA, and the presented model can be criticized for not reaching up to that recommendation. Further, the items within each subscale were unidirectional and thus, the lack of reversely phrased items can be criticized (cf. Carifio & Perla, 2007). However, comparing items within the hypothesized subscales (Table 1, still containing bidirectional items) shows that on average, the sophistically oriented items score higher than naïvely oriented items, which indicates that the items measure accurately.

As factor analyses often show (e.g. Bråten et al., 2005; Chiu et al., 2013; Leal-Soto & Ferrer-Urbina, 2017; Schraw, 2013), the model arrived at in the exploratory procedure is not necessarily identical with the hypothesized conceptual model, regarding neither item set nor factor structure, as was the case here. The results of an EFA are not sufficient to confirm a model (Osborne, 2014, pp. 19, 49) and therefore, the model arrived at was subject to an internal replication, i.e. EFA and CFA on randomized split half data sets (Table 4, Figure 2). These analyses largely hold the same factor structure as the initial EFA model, thereby confirming it. In both split halves, the same inter-factor correlations as in the initial model recurred, which also applies for the cross-loading items k10_7 and k14_5.

5.4.2 Data considerations

In addition to methodological issues discussed above, the usability and relevance of the current data set (stemming from 2012) should be assessed against the aim of the study and the research question, while

taking into account if and to which extent the past years' technological development has changed the cognitive operating environment.

Firstly, the aim of the study, as expressed in the research question, was not a validated version of a new instrument but rather, a first exploration of new epistemic dimensions that might contribute to a more nuanced epistemic profile, especially regarding the googling attitude. For this purpose, the data set proved sufficient.

Secondly, the googling attitude is highly dependent on access to internet and search engines. As reported earlier (section Research data and sample characteristics), not much has changed on that point. By 2012, internet penetration within the sample and in Finland had long been close to 100% (OSF, 2010; OSF, 2011), and the majority of the informants had a long history of internet exposure. After 2012, the width of services over mobile devices has undeniably increased beyond browsers and search engines to various applications, probably inducing use habits that rely even more on ubiquity. It is not far-fetched to assume that users today may be even more prone than in 2012 to consult internet-based sources. Consequently, if the current research data can demonstrate even weak signs of a googling attitude, then the data fulfils its purpose and one may assume that a newer set of data would reveal even clearer signs.

To conclude, the current data set has served the aim and provided an answer to the research question of the current study as for the current sample. As further elaborated in the concluding section, I did not produce a validated instrument. Still, the results corroborate the initial assumption about a connection between the googling attitude and epistemic beliefs and encourage further development along this line. Should we choose to regard the current results simply as expressing the 2012 state of affairs, the results will still be relevant for historical comparison.

6 Conclusions

6.1 Dimensions and constructs

In the present study, five novel dimensions were introduced and operationalized in 33 items, based both on literature about so-called Digital Natives and learning in the digital era as well as empirical observations. Three novel dimensions, described by thirteen items, survived the process; *Constructivist approach, Internet reliance* and *Learning by dialogue*.

The dimension *Constructivist learning approach* appeared as a rather stable dimension, correlating strongly with *Learning ability* and moderately with *Learning by dialogue*. These correlations are conceptually coherent, as is the lack of correlation to *Omniscient authority*. The latter suggests that having a constructivist learning approach does not exclude believing that an *Omniscient authority* can be an important source of knowledge but rather, the *Constructivist learning approach* can be regarded as a learning aspect supplementing *Omniscient authority*, describing a knowledge aspect.

Learning by dialogue was mainly inspired by the connectivist model suggested by Siemens (2005; 2006), but during the analyses a picture emerged, where this dimension mainly deals with learning and construction of knowledge as a social process. Just as the dimension *Constructivist learning approach*, *Learning by dialogue* provides a learning aspect not captured by previously described dimensions.

Internet reliance poses a dimension with a knowledge aspect, not covered by previous instruments, and is probably the dimension that most of all expresses the googling attitude referred to in the introduction. Furthermore, it expresses a way of relating to knowledge that has not been possible before. Indeed, during the pre-internet era it was possible to offload your memory to books or other external media. However, due to access, time and distance barriers, *"looking it up in a book"* was not an option of the same range as *"looking it up on the net"* (cf. Fisher et al., 2015). Thus, since the introduction of internet, it is in fact possible to refrain from memorizing and instead to offload one's memory and to rely on finding the information on the net, immediately and once you need it, which is not a problem per se. The problems and risks lie in the confusion

of knowledge and information, where the ubiquitous access to information creates the illusion of possessing personal knowledge (Fisher et al., 2015). Technology developing and becoming more powerful accentuates this problem, when not only information storage but also information processing is outsourced, thereby changing our epistemic practices (Säljö, 2012; Sparrow et al., 2011).

The confusion of knowledge and information can also be viewed from the perspective of cognitive processing as described e.g. in the extended version of Bloom's taxonomy (Krathwohl, 2002). If a person is to achieve a deeper level of knowing about a topic, the first level, Remembering or 'knowing-that', is always a prerequisite for moving on to Understanding, Applying, Analysing, Evaluating and Creating. In this perspective, the googling attitude suggests a 'knowing-where' (Siemens, 2006, p. 10), which can be regarded as a stage of external information, possibly preceding Remembering. However, not until that external information has been memorized and transformed into a 'knowing-that' as part of the personal body of information, it can enable the following levels of knowing.

6.2 Epistemic awareness and educational practice

Muis et al. (2006, p. 42) have drawn our attention to that students should be made aware of their epistemic beliefs, since this awareness may be important for epistemic change. The same challenge has recently been addressed by Bhatt & MacKenzie (2019) but now with focus on the internet context and digital literacy. Thus, epistemic awareness is a component in epistemic competence for both teachers and learners.

Much of the pedagogical potential of the novel dimensions can be deduced from the cross sea between changing pedagogies and the new learning environments emerging with new ICT and media. Many teaching methods and learning activities, such as the flipped classroom (cf. Knewton, 2011) and PBL (cf. Otting et al., 2010), increase the demands on students' self-regulation and their ICT and media literacy (cf. Muis, 2007; Brownlee et al., 2009; Walker et al., 2009; Bhatt & MacKenzie, 2019). Thus, if a study programme is built e.g. upon PBL, it is useful to know to which extent the students in a new group actually have a *Constructivist approach* and readiness for *Learning by dialogue*, and how to support students' self-directedness. Should it turn out that many students lack these prerequisites, appropriate interventions can be applied to develop their epistemic mind-sets on these dimensions, thereby improving their academic performance.

Increased understanding regarding both teachers' and students' epistemic beliefs has been called for (cf. Palmer & Marra, 2008, p. 345). If the novel dimensions can increase awareness regarding the connection between epistemic beliefs and learning tasks over changes in epistemic beliefs by intervention (cf. Kienhues et al., 2008), they have the potential of contributing to instruction and learning strategies that are better aligned to both learning objectives and the learners' epistemic orientations.

Due to internationalization and student mobility, classes will increasingly hold students and teachers with diverse cultural backgrounds. Thus, if epistemic beliefs are dependent on cultural background as suggested by e.g. Zhang & Watkins (2001) and Hofer (2008, pp. 11-12), then awareness about this connection is increasingly important for the teacher to support and guide the learning processes in a multicultural class with students holding diverse, culturally induced, epistemic orientations.

The most crucial finding of this study is the introduction of the *Internet reliance* dimension. Identifying students with a naïve stance on this dimension may prove important especially if these students are over-reliant towards internet-based resources (cf. Bråten, 2008, pp. 369-370). If so, they are at risk of developing an ever-narrowing worldview and an epistemology of ignorance resulting from the ranked and filtered results provided by search engines (cf. Bhatt & MacKenzie, 2019; Hinman, 2008, p. 73; Nguyen, 2018).

6.3 Future research

The results presented above respond to the openly phrased research question by confirming that it is indeed possible to extend epistemic dimensions so that they also express the googling attitude. This is, however, only part of the answer: the novel dimensions need to be further tested e.g. by exploring whether

they show between-groups variations congruent with the googling attitude they are expected to express. A connection between epistemic beliefs and academic performance has been suggested (e.g. Aditomo, 2018). If the instrument for measuring epistemic beliefs can be developed to measure more precisely, it will probably have a predictive value in assessing each student's epistemic competence in relation to study context, and a value for teaching practices in supporting students' epistemic competencies by appropriate choice of learning activities. On this point, the picture is disparate with both encouraging (Pieschl et al., 2014) and discouraging (Knight et al., 2017) results and thus, epistemic beliefs as predictors of learning behaviour seems an under-researched area. However, net-based learning environments (LMS, VLE) having started to include learning analytics features will provide better possibilities to investigate the connection between students' epistemic dimensions and trace data from authentic learning contexts, i.e. courses.

There are indicators suggesting that epistemic beliefs dimensions should be measured on a sufficiently fine-grained level, since coarsely composed dimensions as the General Internet Epistemology (Knight et al., 2017), will blur the picture. The study by Trautwein & Lüdtke (2007), focusing on the certainty dimension, is an interesting initiative in this line. The recent study by Bråten, Brandmo & Kammerer (2018) expresses what we might call increased granularity: besides focusing only on the *Justification* dimension, they divide it into three sub-dimensions, justification by authority, multiple sources and personal knowledge. These examples, together with earlier replication problems (Schraw, 2013) expose a challenging tension: should we measure epistemic beliefs as a set of dimensions or as separate constructs?

The proposed model arrived at (Table 3) and confirmed by internal replication (Table 4 and Figure 2) shows fit indices that are not ideal but sufficient to encourage further development. Despite deficiencies, the model provides an interesting input to the debate whether epistemic beliefs should include only views on knowledge, or also views on learning. The CFA path diagram (Figure 2) provides an illustration to this debate: two groups of latent variables, the upper group describing views on learning, and the lower one describing views on knowledge. It is not far-fetched to imagine two second-level latent variables, influencing views on knowledge and views on learning, respectively (cf. section Correlating dimensions). The correlations within the two groups of latent variables, especially the strong correlation between *Constructivist approach* and *Learning ability*, also point in this direction, and exploring second-level latent constructs is a topic for further investigation.

Topics dealing with the instrument itself include 1) developing the instrument such that each dimension would be represented by more than only three items (cf. Carifio & Perla, 2007), 2) improving items with low loadings, and 3) exploring the discarded items regarding common features that might have contributed to their dysfunctionality. In addition to these topics, the functionality of the model should be tested by exploring how well the dimensions distinguish different learners. This will be done by exploring if and to which extent dimensional group differences can be identified e.g. across users representing different digital orientations or study domains.

The extensions to the epistemic beliefs instrument and the proposed (but not validated) model are, needless to say, only a beginning. Considering the twenty years of history with SEQ and its successors gives an idea of the work that still lies ahead.

Keypoints

- The novel dimension *Internet reliance* may help in identifying learners that are over-reliant towards Internet-based resources.
- Beliefs about learning contribute to describing one's epistemic orientation, although they are not regarded as part of the epistemic beliefs concept.
- Although assumed to develop independently, the epistemic beliefs dimensions correlate when using an appropriate rotation method.
- The novel dimensions contribute to an epistemic awareness and to adapting instruction and learning practices to learners' epistemic orientations.
- An increasingly international learning context and multicultural student body requires awareness about culturally induced epistemic orientations.

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PUBLICATION III

Epistemic beliefs and internet reliance – is algorithmic authority part of the picture?

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Epistemic beliefs and internet reliance – is algorithmic authority part of the picture?

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Abstract

Purpose – The internet and search engines dominate within people's information acquisition, especially among the younger generations. Given this trend, this study aims to explore if information and communication technology (ICT) practices, internet reliance and views of knowledge and knowing, i.e. epistemic beliefs, interact with each other. Everyday practices and conceptions among beginning undergraduate students are studied as a challenge for higher education.

Design/methodology/approach – The study builds upon survey-based quantitative data operationalising students' epistemic beliefs, their internet reliance and their ICT practices. The survey items were used to compute subscales describing these traits, and the connections were explored using correlations analysis.

Findings – The results suggest that the more beginning undergraduate students rely on internet-based information, the more they are inclined to epistemic beliefs where knowledge is regarded as certain, unchanging, unambiguous and as being handed down by some authority.

Research limitations/implications – The approach used in the study applies to the sample used, and further research is required to test the applicability of the approach on larger samples.

Practical implications – The study highlights the risk of everyday information practices being transferred into the educational context.

Social implications – Ignorance of these changes may pose a risk for knowledge building on different educational levels and in a longer perspective, a threat to democracy.

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Originality/value – While there is some research on epistemic beliefs in relation to internet-based information, studies approaching the problem over a possible connection between epistemic beliefs and internet reliance are scarce. In addition, this study implies a conceptual bridge between epistemic beliefs and internet reliance over the concept of algorithmic authority.

Keywords Digital literacy, Internet, Search engines, Algorithmic authority, Epistemic beliefs, Reliance

Paper type Research paper

1. Introduction

Around the turn of the millennium, terms such as digital natives (Prensky, 2001) were in focus of both public and scientific debates. Within the rhetoric of that time, the whole millennial generation was described as digitally oriented and net-savvy (see, e.g. Judd, 2018). It is evident that information and communication technologies (hereafter ICT) and the internet took a more dominant role in the everyday life of the Net Generation but it is also a fact that the Net Generation is internally heterogeneous. Many but not all young individuals are skilful in using ICT. Internet services are important in their everyday life and this also affects their behaviour as students (Andersson, 2017; Huvila, 2013; Jones and Hosein, 2010; Lai and Hong, 2015; Litt, 2013; Ståhl, 2017).

One special aspect of the Net Generation is the use of internet search engines that became commonplace in the late 1990s (The Real Time Statistics Project, 2020; Wall, 2017). Google was launched in 1998 and soon became the dominant service. The verb "googling" is an expression for this universality. Google has become a synonym for search engines and "googling" a synonym for information searching (Andersson, 2017; Sundin *et al.*, 2017). Easy access to the vast information resources of the internet radically changed the practices of information acquisition. The change was anecdotally assigned to the Net Generation in the slogan: "Why don't you just google it?" This response to a question can be interpreted as a strong belief in googling as the appropriate action when encountering an information problem.

Easy access to information by googling and positive experiences in solving everyday information problems increased youngsters' reliance on the internet. In formal education, this development raised worries of students' information retrieval strategies being counterproductive in terms of knowledge building (Forte and Bruckman, 2009; Sormunen and Lehtiö, 2011). Students' reliance on internet-based information resources and googling seems to increase tendencies to reduce genuine problem-solving into fact-finding searches or even copy-pasting (Andersson, 2017; Limberg *et al.*, 2008; Sormunen and Lehtiö, 2011; Walraven *et al.*, 2009). Sundin *et al.* illustrate this change using the concepts of *search-ification* [of everyday life] and *mundane-ification* [of search]. Search-ification stands for an everyday practice of online searching as a self-evident, unquestioned and frequent activity. Mundane-ification refers to a change where distinctive, identifiable and goal-oriented searches dissolve into the constant stream of everyday practices (Sundin *et al.*, 2017).

These tendencies raise a fundamental question: could novel net-based information practices and reliance on the internet search engines change students' views of knowledge and knowing, i.e. their epistemic beliefs (cf. Barzilai and Zohar, 2012; Gunter *et al.*, 2009, pp. 2–3)? Considering the fact that users, to a large extent, build their knowledge upon the information they are offered by search engines, the connection to the users' epistemic beliefs is paramount. As Simon (2010) presents it, search engines can be regarded as epistemic agents, besides human agents. In their epistemic

practices, users place trust in both kinds of agents and the content delivered by them. Some studies have found a connection between reliance on internet-based information and a belief in knowledge as simple facts (Strømsø *et al.*, 2011) and a connection between the latter and superficial reading (Strømsø and Kammerer, 2016). Therefore, we felt that there was a need to explore how students' *ICT practices* and inclination to *internet reliance* relate to their *epistemic beliefs*.

The questions regarding internet reliance and epistemic beliefs are crucial from the perspective of higher education. Undergraduate students are often in the middle of a life transition from adolescence to adulthood. In addition, starting their tertiary level professional studies also involves a transition where they are expected to adopt academic conceptions about information, knowledge and learning. The internet practices and conceptions acquired in adolescents' everyday life are a potential challenge for higher education. We feel it necessary to gain a better understanding of these issues to guide the development of curricula, teaching and learning at university. Thus, the goal – and the scope – of this study is to find out how ICT practices, internet reliance and epistemic beliefs relate to each other among incoming undergraduate students.

2. Previous research

2.1 Epistemic beliefs

2.1.1 The concept. Research on personal epistemology or epistemic beliefs is an established field within educational research. While epistemology as a branch of philosophy engages in the origin, nature and limits of knowledge and knowing within a discipline, the term epistemic is about knowledge and knowing on an individual level (see, e.g. Hofer, 2002, p. 3). Thus, the concept of epistemic beliefs describes what kind of beliefs individuals hold about knowledge and knowing (Hofer and Pintrich, 1997; for an overview, see, e.g. DeBacker *et al.*, 2008).

Marlene Schommer introduced the line of research where epistemic beliefs are regarded as a set of dimensions, developing more or less independently from each other (Schommer, 1990). Later studies (e.g. Ferguson and Bråten, 2013; Kienhues, 2016; Mierwald *et al.*, 2018; Muis and Duffy, 2013) have confirmed that epistemic beliefs are susceptible to change. In her first version, Schommer suggested five epistemic belief dimensions which she labelled as *Omniscient authority*, *Certain knowledge*, *Simple knowledge*, *Learning ability* and *Learning speed*, thus including learning-related dimensions. Hofer and Pintrich (1997) suggested excluding the learning-related dimensions and instead structured the dimensions into two general areas: 1) *nature of knowledge*, including *Structure and Certainty of knowledge*, and 2) *nature of knowing*, including *Source of knowledge* and *Justification for knowing*.

Certain(ty of) knowledge expresses that one regards knowledge as certain, absolute and unchanging but not tentative or evolving. *Simple (structure of) knowledge* expresses a view that knowledge consists of unambiguous, isolated bits instead of complex or highly interrelated concepts. *Omniscient authority* (or *Source of knowledge*) assumes that knowledge is always handed down by authority rather than derived by personal reasoning. The dimensions are here expressed from what Schommer (and several successors) described as a "naïve epistemological persuasion" (Schommer, 1990, 1998). The fourth dimension, *Justification for knowing*, originally described how individuals evaluate knowledge claims, that is, how they use and evaluate evidence and authorities, respectively (Hofer and Pintrich, 1997). Later studies have suggested that *Justification for knowing* in itself is a multi-dimensional construct, consisting of

Justification by authority, *Justification by multiple sources* and *Personal justification* (Bråten *et al.*, 2019; Ferguson *et al.*, 2013; Strømsø and Kammerer, 2016, p. 244). Thus, measuring and exploring it poses a special challenge.

The first decade's conceptualisation of epistemic beliefs as being naïve or sophisticated does not consider if an epistemic belief is productive or not. Here, productive stands for a belief that promotes a behaviour or an attitude that leads to progress as defined either by the learner or by the (learning) community (Elby and Hammer, 2001). The issue about a belief being productive is closely related to whether or not an epistemic belief is measured in relation to, and within, a specified domain, context or subject area (Alexander and DRLRL, 2012; Elby and Hammer, 2001; Elby and Hammer, 2010, p. 431; Grossnickle Peterson *et al.*, 2017, pp. 257–258). Citing the example by Elby and Hammer (2001), it is hardly productive to view the idea that the earth is round rather than flat, as tentative. By contrast, it is productive to view theories of dinosaur mass extinction as tentative and evolving, because new facts are continuously being discovered, altering and/or refining existing theories. Thus, an epistemic belief viewing knowledge as tentative and evolving can be either productive or non-productive, as in the example, depending on domain.

Muis *et al.* have presented results confirming that, although students' beliefs are unique to particular domains, they are still also related across domains, everyday life being one of these. Thus, when lacking experience from a specific domain (e.g. psychology), students based their responses on another, familiar domain (everyday life) (Muis *et al.*, 2016).

2.1.2 Measuring epistemic beliefs. By developing the first instrument to measure epistemic belief dimensions, the Schommer Epistemological Questionnaire (hereafter SEQ), Schommer (1990) also introduced the line of research where epistemic beliefs were measured using self-report questionnaires. The SEQ instrument has been followed by several successors (e.g. FEE by Moschner *et al.*, 2005; EBI by Schraw *et al.*, 2002; EBS by Wood and Kardash, 2002), where both the dimensions and their corresponding items have varied. In these questionnaires, the items were expressed as statements to which responses were collected on an anchored disagree–agree scale. Another common denominator was that the items were exploratory factor analysed to extract the epistemic belief dimensions. The studies by DeBacker *et al.* (2008) and the review article by Gregory Schraw (2013) provide informative overviews.

2.1.3 Epistemic beliefs and the internet. Around the millennial shift, as the internet started to be broadly accessible, researchers started showing interest in how this new information and media context is reflected in epistemic beliefs. Bråten *et al.* (2005) urged for research that would explore knowledge building with internet resources in the light of epistemic beliefs and developed the Internet-Specific Epistemological Questionnaire instrument that focuses on internet-specific epistemic beliefs. Although aiming at four dimensions, their analysis reduced the dimensions to two (General internet epistemology and Justification for knowing), thus omitting an exploration of the relationships between other dimensions (as previously described by, e.g. Schommer, 1990; Schraw *et al.*, 2002, p. 265; Wood and Kardash, 2002, p. 245). However, Bråten *et al.* (2005) showed that users, when being over-confident in the internet as an authoritative and trustworthy source (cf. internet reliance), do not necessarily realise the challenge in this cornucopia of information.

Strømsø *et al.* (2011) concluded that students, who believed that knowledge consists of simple facts (Structure of knowledge), tended to be less critical about the information source (cf. internet reliance). Further, Strømsø and Kammerer (2016, p. 250) refer to

several studies indicating that students who believe in simple and certain knowledge engage more in superficial online reading, which may also indicate a connection to internet reliance.

In the current era, with the almost unlimited access to information, the issue of information and digital literacy is recognised as fundamentally epistemological (Hofer, 2016, p. 29). Thus, the opening phrase "Why don't you just google it?" needs to be taken seriously.

2.2 Internet reliance

For most people, both young and adult, the tendency of "looking it up on the net" is probably a result of many positive experiences where the search engine has helped users to find the "trivial everyday information" they are looking for. This has led to a preference for convenience at the cost of critical review. For example, Biddix *et al.* (2011) and Alexander and DRLRL (2012), with reference to several studies, point out that the challenge associated with the current wealth of ubiquitous information is that easy access is valued higher than the quality of information. Thus, the risks we see are threefold: knowledge building can be replaced by fast searches; easiness and convenient access pass source critics in the background; and we fall into the trap of trusting the search engine's algorithm without knowing in whom we trust.

First, search engines provide easy access to various information resources that the user might not even anticipate to exist (see, e.g. Wall, 2017). On the other hand, search engines play an increasingly important role as gatekeepers by regulating the information that the user is exposed to (see e.g. Hinman, 2008; Simpson, 2012). In the current media environment, the tendency to rely on search engines raises concerns regarding the users' (lacking) awareness of their search strategies and capability to assess the trustworthiness of the information they stumble upon, either by clicking through links or by opening links offered (and tailored) by search engines. Huvila's (2013) results indicate that simply when something is found on the net, this is regarded as positive evidence of its veracity. Sundin *et al.* (2017) refer to several studies showing that also information, which we encounter seemingly by accident, is actually algorithmically generated and personalised. Personalisation is both explicit, based on the user's input, and implicit, based on covertly collected data describing the user's activities. Visibility in the search results is also attained on a commercial basis through advertising (Mößner and Kitcher, 2017).

Second, for example, Purcell *et al.* (2012) report that 66% of an American adult sample believe that search engines provide unbiased information, and the vast majority report that they find what they are looking for always (29%) or most of the time (62%). These high scores obviously indicate that the enquirers commonly experience search engines as effective tools in their everyday life. In addition, search engines seem to succeed in tailoring the search results to meet users' expectations. These findings are in line with the findings of Barzilai and Zohar (2012), who report that students in an Israeli sample evaluated the trustworthiness in only 39% of the websites they read, and that the majority could not even describe how they would go about evaluating the trustworthiness of websites. A more recent study indicates that the belief in search engines providing "serious answers" seems to persist (Andersson, 2017).

Thus, a reliance on internet-based resources poses a risk that the individual develops an ever-narrowing world view resulting, e.g. from the tailored search results. According to Hinman (2008, p. 73), search engines actually have the capacity to influence the individual's knowledge building through control of access. Search engines are designed to tailor the search results, but in doing so, they also distort the search

results (Halavais, 2013, p. 249). Furthermore, Fisher *et al.* (2015) address the risk that ubiquitous access to information may blur the boundaries between internal knowledge and external information, thus creating an illusion of possessing personal understanding.

Knowledge building within higher education and academia requires that findings and claims are critically evaluated before they end up as part of the discipline's body of knowledge, where they either corroborate or overturn previous knowledge. As academic institutions are now forced to compete with the multiplicity of ubiquitous information, they are facing a challenge, concisely worded by Bhatt and MacKenzie:

> The idea that multiple sources which say the same thing equates to corroboration and validation [. . .] has its origins within the academy, but cannot be assumed of online searches (Bhatt and MacKenzie, 2019).

Simpson (2012) regards the search engines' personalisation feature as an actual threat to objectivity, because the personalised search results will tell the user only what (the search engine assumes) he/she wants to hear or what apparently interests him/her. The search results will not tell the user what he/she should know but does not want to hear. The problem is accentuated by the fact that users are often unaware of the implicit personalisation (Mößner and Kitcher, 2017). This may also apply for social media and other online environments, where likes and shares are commonly used and regarded as a kind of social validation (Sahut and Tricot, 2017). Likes and shares are, however, spontaneous and subjective reactions, which lack most criteria for validation, and cannot be interpreted as or equated with scientific validation.

Third, in a situation where the user trusts a search engine by assuming it as trustworthy as a human actor, the user falls in the trap of trusting an "algorithmic authority". Andersson (2017) reports that teenagers are unaware of the search engine's algorithms. They seem to believe that search engines give a quality warrant, similar to materials used at school, for information sources found online. Thus, the algorithmically produced search results are perceived as if they were produced by a human. Algorithmic authority is a concept first coined by Clay Shirky in 2009 (original source not available; see Sundin *et al.*, 2017). Shirky's original definition was later modified by Lustig and Nardi (2015) to read "the trust in algorithms to direct human action and to verify information, in place of trusting or preferring human authority". In such a situation where the search engine is in the position of an algorithmic authority, the user (unknowingly) allows the search engine's algorithm to assess both relevance and credibility, thus allowing it to "direct human action".

To conclude, because epistemic beliefs are susceptible to change (Ferguson and Bråten, 2013; Kienhues, 2016; Mierwald *et al.*, 2018; Muis and Duffy, 2013), we have reason to fear that not being challenged but, instead, being exposed mainly to concordant and non-conflicting information will not contribute to an individual's epistemic development. Instead, there is a risk that the individual remains in an epistemic bubble, defined by Nguyen (2020) as "a social epistemic structure which has inadequate coverage through a process of exclusion by omission". Nguyen further states that among the forces encouraging this omission are the processes and agents that modify an individual's information landscape. In the current media context, the personalisation performed by search engines is explicitly such an agent (cf. Hinman, 2008; Mößner and Kitcher, 2017; Simpson, 2012). This poses an obvious threat to the epistemic development that is central to higher education.

2.3 Information and communication technology practices

As mentioned in the Section 1, the aim of this study was to explore epistemic beliefs and internet reliance in relation to ICT practices. The past decades' rhetoric regarding the Net Generation as digitally oriented and frequent users of a broad range of technological activities suggests that there could also be a connection to frequent use of the internet and other digital resources and gadgets. Thus, it was necessary to describe these practices among our target group. For this purpose, we sought inspiration from a number of studies where the use habits and preferences of the supposedly digital generation had been explored and described.

Prensky (2001) promoted the (now outdated) assumption of digital natives being both ICT savvy and heavy users of a multitude of technical devices, although without evidence (Judd, 2018). Other studies provided survey-based descriptions of the traits, practices and preferences of the young generation. According to Horrigan (2007) and Kennedy *et al.* (2010), the young generation was committed to a culture of sharing, e.g. pictures, status updates, likes, etc. Lenhart *et al.* (2010) described the young generation as active users of the internet and social media, and also as bloggers, although the latter one showed signs of decline.

By surveying use habits, Kennedy *et al.* (2010) and Jones and Hosein (2010) identified different groups and thereby the heterogeneity within the young generation. Van den Beemt *et al.* (2011) surveyed actual use among a large sample of users, and identified patterns of technology-based activities that they labelled Interchanging, Interacting, Performing and Authoring. Kennedy *et al.* (2010) also used data regarding technology-based activities to create use patterns labelled Advanced Mobile Use, Media Sharing, Creating and Using Media, Gaming, Standard Mobile Use, Standard Web Use and Web 2.0 Publishing. They also used the use patterns to describe different types of users.

There is not an existing and generalisable definition of different groups of internet, ICT and digital news media users, but as the aforementioned studies show, it is possible to identify use patterns. Although use patterns may be used to distinguish different kinds of users or even to create typologies, both use patterns and typologies will, however, be dependent on both the sample and on the contemporary, rapidly changing technological context.

2.4 Current study

Given the combination of confidence (perhaps even over-confidence) in online sources, search engines, questionable validation practices, exposure to a narrowing set of information and uncertainty in distinguishing between personal knowledge and external information (previous sections), we see that some users may be at risk of building their knowledge on a biased and unstable ground. We obviously need more research-based information about young people's epistemic beliefs and, specifically, if and how they are connected to their internet reliance and to their ICT practices.

In the current study, we used the sample at hand (see the following sections) to provide an opening for research that contributes to methods for gaining better insight into students' epistemic thinking. We tackle the problem by using the survey responses from our existing sample to explore the following questions (visualised in Figure 1):

RQ1. What is the connection between students' *internet reliance* and their *epistemic beliefs*?

RQ2. What is the connection between students' *internet reliance* and their *ICT practices*?

RQ3. What is the connection between students' *epistemic beliefs* and their *ICT practices*?

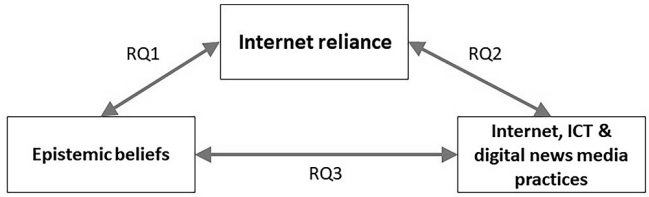

Figure 1.
Research questions

3. Method

3.1 Participants

The sample used in this study consists of a cohort of new students (n = 440) at a Finnish university of applied sciences. The university offers 15 degree programmes ranging from health, welfare and culture to business and engineering. About 86% of the students were domestic and 14% represented 32 other nationalities (Table 1).

Study area	Students
Business and hospitality management	139
Culture	33
Engineering	65
Healthcare	92
Welfare and social work	111
Total	440

Table 1.
Sample distribution across study programmes

The sample comprised 63.6% female students, and 81.8% of the students were in the age range 19–23 years, giving an age average of 21.7 and a median of 21.0.

3.2 Data collection

The students were invited by personal email messages in which they were informed about the aim of the study and that participation was voluntary. Because this study was part of the university's development strategy (and approved by the ethical board), it was possible to organise data collection as scheduled sessions in a computer classroom. Data collection was organised during the very first week of the semester, prior to exposing students to study subjects or pedagogical influences, to capture a "snap-shot" of their epistemic beliefs as they enter university. The students' context is worth noting: because they were just about to start their tertiary-level professional studies, they were not yet familiar with the profession-oriented subjects or academic studies. Therefore, the survey was not connected to a subject or domain but instead students were instructed to reflect upon the epistemic statements on a general level and against the background of their everyday experiences [cf. the general knowledge context described in Muis *et al.* (2016)].

The instruments used for data collection were presented as online questionnaires. After data collection, the data sets were merged and anonymised. In the following subsections, the instruments are presented first on the item level and then as subscales. In the study, we operated with three sets of units of analysis: Epistemic belief dimensions; internet reliance; and ICT practices. For the units of analysis, we created subscale scores using the mean.x function (SPSS, 2016), which allows computing a subscale score only for those cases that contain a specified number x of substantive responses, that is, valid values on the response scale. Thus, in Tables 2–4, e.g. the numbers (5/6) after the subscale label denote that subscale scores were computed only for those respondents that provided substantive answers for at least five out of the six items within that subscale. Because of varying non-response, the number of cases for each subscale varies.

3.2.1 Epistemic beliefs. To collect data regarding epistemic beliefs, we used an inventory that was compiled from previous instruments (e.g. FEE by Moschner *et al.*, 2005; SEQ by Schommer, 1990, 1998; EBI by Schraw *et al.*, 2002; EBS by Wood and Kardash, 2002) and where experiences gained from these were considered (cf. DeBacker *et al.*, 2008). The participants responded to the statements on a six-point anchored disagree (1)–agree (6) scale that had been developed and used in a previous study (Ståhl, 2019). When developing the inventory, the item phrasings were tested in read-aloud sessions with both domestic and international students, and after data collection, the dimensions were extracted using exploratory factor analysis. The resulting model was further tested using exploratory and confirmatory factor analysis on split-halves of the data set. Building upon that model, the current instrument contained 23 statements representing three dimensions of epistemic beliefs. The items and the instructions were generic and did not refer to any domain, specific subject or academic discipline (cf. Muis *et al.*, 2006, p. 25; Muis *et al.*, 2016; Wood and Kardash, 2002, p. 244). The 18 items retained in the final subscales presented in the current study were all unidirectionally oriented so that they express a belief in knowledge as certain, absolute and unchanging, as consisting of unambiguous, isolated bits and always being handed down by an omniscient authority (Table 2).

Likert-type scales are often subject to critique but commonly used both with odd (Muis *et al.*, 2016) and with even categories (Bråten *et al.*, 2019). Much of the critique stems from a confusion between the Likert item as a response format and the Likert scale, which is a multicomponent measurement based on the item responses (cf. Bishop and Herron, 2015; Norman, 2010). In the current study, we did not analyse the item responses as such but used them to compute subscales for the units of analysis.

A response scale with even categories may be interpreted as forcing the respondent to choose. To avoid this, but also to improve accuracy, the response scale was extended with the non-substantive options "Don't understand" and "Don't know" that were positioned at each side of the substantive options in order not to distort the visual midpoint of the response scale (cf. Tourangeau *et al.*, 2004). The non-substantive responses were treated as missing values during analyses but provided valuable information about item quality. Considering the aim of this study (see Section 1) and the arguments presented above, we considered the use of Likert-type items as appropriate.

We acknowledge the need to view epistemic beliefs in a more nuanced way, e.g. by viewing Justification of knowledge as three-dimensional (cf. Bråten *et al.*, 2019; Ferguson *et al.*, 2013) and by applying multiple methods (Muis *et al.*, 2016). Although we acknowledge the importance of Justification of knowledge, we chose to omit it from

this study. The reason is that, because of its complex multi-dimensionality, we deemed Justification of knowledge too challenging to apply simultaneously with other dimensions in the available data set. Narrowing the scope is common when exploring new concepts or previously undescribed relations between them. Further, we chose not to connect the exploration to either domain (Muis *et al.*, 2016) or to context (Grossnickle Peterson *et al.*, 2017, pp. 257–258), because these were difficult to apply in the group of incoming students. Thus, we delimit our study to exploring epistemic beliefs in the general domain of everyday knowledge (cf. Section 2.1.1 about epistemic beliefs being related across domains).

Consequently, because the statements were not connected to any specific domain or context, it was neither possible nor relevant to assess if the beliefs were productive (Section 2.1.1). Instead, the epistemic beliefs are described according to their original characteristics, as certain, absolute and unchanging, as consisting of unambiguous, isolated bits and always being handed down by an omniscient authority.

Table 2.
Epistemic belief items used in the survey, and the three epistemic belief dimension subscales based on 18 out of the 23 associated items

Subscales and items	Cases	Cronbach's alpha	Item-total corr.
Omniscient authority (5/6)	334	0.728	
I have to accept the answers from a teacher as true			0.532
Teachers are almost always right			0.518
All teachers will probably arrive at the same answers regarding issues within their field			0.468
I seldom or never question authorities			0.459
I can believe almost everything I read as part of my studies			0.417
All experts within a field have the same understanding regarding the basic issues of that field			0.380
Forming my own ideas about a topic is more important than learning what the textbooks say			–
Certainty of knowledge (3/4)	326	0.631	
There are scientific facts that will never change			0.532
There are truths that will always stand			0.433
Scientific research shows that there is one correct answer to most problems			0.383
A true fact today will also be a true fact tomorrow			0.311
I like teachers who present several different views and let me decide which is best			–
Truth can mean different things to different people			–
Structure of knowledge (7/8)	327	0.742	
It bothers me when teachers do not tell me the answers to complicated problems			0.538
It bothers me when a teacher does not say clearly what I am supposed to know in an examination			0.472
I find it annoying to listen to teachers who cannot make their mind up about what they believe			0.437
I prefer topics where most problems have only one right answer			0.433
When I study, I mostly concentrate on specific facts			0.422
To be a good student I try to memorize lots of facts			0.412
I like teachers who organize their lectures carefully and then stick to their plan			0.396
Teachers should focus on simple facts instead of complicated theories			0.377
To me, studying means getting the big ideas from the text rather than details			–
I try my best to combine information across chapters or even across classes			–

The factor extraction performed in a previous study (Ståhl, 2019) would have allowed using factor scores but at the cost of a strongly reduced number of cases. Therefore, we decided to compute subscale scores for the epistemic dimensions. Starting with all items anticipated for each dimension, we used internal consistency tests and information from the earlier factor extraction to guide the process of deciding which items to include in each subscale score. The aim was to create the most reliable subscales possible while retaining as many items as possible. The process resulted in the subscales presented in Table 2.

3.2.2 Internet reliance. To operationalise the degree of reliance on internet-based information, we used a set of items expressing a belief that internet-based information is throughout good and useful. The statements were inspired by descriptions of the supposedly net-savvy young generation and the way they use the internet (Section 2.2). The items were presented on the same kind of six-point anchored disagree–agree scale as the epistemic items.

Applying the same logics as with epistemic belief subscales, the internet reliance subscale score was tested for internal consistency and computed as an unweighted average using the mean.x function, in this case requiring substantive values for at least four items. As illustrated in Table 3, all statements were equally oriented, and thus high item and subscale scores express a high level of internet reliance.

Subscale and items	Cases	Cronbach's alpha	Item-total corr.
Internet reliance (4/5)	331	0.745	
Internet sources usually provide me with a clearer picture of subjects than do books			0.585
Wikipedia is reliable because it is up-to-date			0.536
I learn things quicker from internet pages than from books			0.515
Wikipedia is reliable because it is written by many people with different viewpoints			0.491
I can get almost all the information I need to know about a subject from one or two internet sources			0.423

Table 3. Items included in the subscale expressing internet reliance

3.2.3 Information and communication technology practices. In previous studies, various sets of use patterns have been described (Section 2.3). To get a measure expressing the users' ICT practices, we used the Australian "Students' Experience with Technology Questionnaire" SETQ (Gray *et al.*, 2009; Kennedy *et al.*, 2008; used in Kennedy *et al.*, 2010) as a starting point. The questionnaire was modified to correspond to the contemporary Finnish ICT environment regarding e.g. mobile connectivity (OSF, 2012; 2013), and also supplemented with some topics described in previous studies (Section 2.3). Thus, the items measured the users' activity level in terms of use frequencies of both general internet use and the use of specific tools or services.

Similar to the SETQ, the items in Table 4 were introduced with the statement "Below is a list of different ways of using [. . .]. Please indicate how often, on average, you have used [. . .] in each way over the past year". The options were presented on the ordinal scale Never used (0), Once-twice a year, Every few months, Once-twice a month, Once a week, Several times a week, Every day and Several times a day (7), and the responses were stored as values (0–7). The subscale scores were computed using the mean.x function, as illustrated in Table 4.

Subscale and items	Cases	Cronbach's alpha	Item-total corr.
General internet activity (8/9)	*406*	*0.702*	
I use the Web to look up current information			0.484
I use the Web to buy services, e.g. tickets			0.460
I use internet shopping			0.441
I use the Web to look up practical information			0.437
I use the Web to look up reference information for studies			0.376
I use the Web to buy/sell things with private persons directly or by auction			0.318
I use the Web for banking services			0.296
I use the Web for streamed music			0.295
I use internet for instant messaging, chat			0.238
Versatile phone use (4/7)	*401*	*0.839*	
I use a mobile phone to send and receive email			0.579
I use a mobile phone to browse the web			0.560
I use a mobile phone as a personal organiser			0.541
I use a mobile phone to take digital photos or movies			0.515
I use a mobile phone for video calls			0.443
I use a mobile phone as an MP3 player			0.385
I use a mobile phone to play games			0.270
Game playing (2/3)	*404*	*0.767*	
I use Web/LAN to play networked games			0.663
I play games on computer			0.634
I play games on games console			0.408
Sharing pictures and files (2/3)	*401*	*0.605*	
I use the Web to upload and share MP3			0.575
I use a mobile phone to send pictures or movies to other people			0.563
I use the Web to share photographs			0.517
Digital news media use (2/3)	*401*	*0.646*	
I follow the news on some newspapers' websites			0.464
I use an app on my mobile phone to follow the news			0.404
I follow the news on some TV channels' websites			0.403
Blogging (2/3)	*408*	*0.737*	
I use the Web to keep my own blog or vlog			0.634
I use the Web to comment on blogs or vlogs			0.626
I use the Web to read other people's blogs or vlogs			0.539

Table 4.
Subscales and items used to describe ICT practices

3.3 Data descriptors and analysis

Although 440 students participated in the survey, the numbers of cases in the various units of analysis are smaller and differ because of non-response and the mean.x function omitting cases with insufficient substantive responses (Table 5).

Some general observations regarding the data are presented in Table 5.

- The *epistemic belief* subscale scores were close to normally distributed (both |kurtosis| ≤ 1 and |skewness| ≤ 1 for all measures). High subscale scores represent a stronger belief in knowledge as certain, unchanging, unambiguous and as being handed down by some authority.
- The *internet reliance* subscale scores were also about normally distributed and ranged almost over the whole scale. High subscale scores represent a stronger reliance in internet-based information.

Unit of analysis	*N*	Mean	Median	Skewness	Kurtosis	Min	Max
Omniscient authority (5/6)[a]	334	2.99	3.00	0.214	−0.179	1.00	6.00
Certainty of knowledge (3/4)[a]	326	3.38	3.33	−0.037	−0.611	1.00	6.00
Structure of knowledge (7/8)[a]	327	3.87	3.88	−0.106	−0.492	1.88	5.63
Internet reliance (4/5)[a]	331	2.77	2.60	0.496	−0.129	1.00	5.40
General internet activity (8/9)[b]	406	3.70	3.67	0.011	0.663	1.11	6.56
Versatile phone use (6/7)[b]	401	3.46	3.57	−0.195	−0.779	0.00	6.86
Game playing (3/3)[b]	404	2.10	1.67	0.674	−0.305	0.00	7.00
Sharing pictures and files (3/3)[b]	401	1.89	1.67	0.886	0.650	0.00	7.00
Digital news media use (4/4)[b]	401	2.82	2.75	0.311	−0.492	0.00	7.00
Blogging (3/3)[b]	408	2.07	1.67	0.795	0.101	0.00	7.00

Notes: [a]Based on statements, item scale 1-6; [b]based on frequencies, item scale 0-7

Table 5. Descriptors for epistemic beliefs, internet reliance and ICT practices subscales

- The *ICT practices* subscale scores were almost normally distributed, and high subscale scores represent a high use frequency. The activities with higher means were more normally distributed than those with lower means. It is worth noting that the items describing ICT practices applied value labels expressing frequency of use on an ordinal scale (0–7), and that those value labels do not apply to the subscale scores, computed as mean values.

To explore the research questions, correlation analyses were used. The Likert-type items produced values on ordinal scales, where Spearman's rho would have been the method of choice (Coolican, 2014, pp. 530, 536; Finch *et al.*, 2016, p. 113). The units of analysis were, however, subscale scores computed as mean values, and therefore regarded as representing a continuous scale (cf. Norman, 2010). Correspondingly, the results presented in the next sections are based on the parametric Pearson correlation test. The correlations are presented in simplified tables displaying only the correlation coefficients and the significance at categorical level. For all pairs, n is between 314 and 334.

4. Results

4.1 Epistemic beliefs and internet reliance

Having prepared the data as described above, we explored the possible connection between students' internet reliance and their epistemic beliefs. The analysis revealed a positive correlation between internet reliance and all three epistemic beliefs dimensions. The correlations are close to moderate or weak (verbal classification of correlations according to Coolican, 2014, p. 524) (Table 6).

Pearson correlation	Omniscient authority (5/6)	Certainty of knowledge (3/4)	Structure of knowledge (7/8)
Internet reliance (4/5)	0.358***	0.281***	0.360***

Note: ***Correlation is significant at the 0.001 level (two-tailed)

Table 6. Correlations between internet reliance and epistemic beliefs

Because all three epistemic dimension subscales were unidirectionally oriented (cf. Table 2) and considering the orientation of the internet reliance subscale (Table 3), a higher level of internet reliance corresponds to a view of knowledge as certain, absolute and unchanging, as consisting of unambiguous, isolated bits and always being handed down by an omniscient authority.

4.2 Internet reliance and information and communication technology practices

The analysis of students' internet reliance in relation to their ICT practices shows a weak correlation between internet reliance and game playing and digital news media use. Regarding other activities, the low correlation coefficient (<0.2) indicates no relationship to internet reliance (Table 7).

Table 7. Correlations between internet reliance and ICT practices

Pearson correlation	General internet activity (8/9)	Versatile phone use (6/7)	Game playing (3/3)	Sharing pictures and files (3/3)	Digital news media use (4/4)	Blogging (3/3)
Internet reliance (4/5)	0.146**	0.129*	0.226**	0.179**	0.224**	0.064

Notes: **Correlation is significant at the 0.01 level (two-tailed); *correlation is significant at the 0.05 level (two-tailed)

4.3 Epistemic beliefs and information and communication technology practices

The last research question regarded epistemic beliefs and ICT practices, and the result showed that omniscient authority and blogging are the only pair showing a very weak correlation. The other epistemic dimensions did not correlate with any of the ICT practices (Table 8).

Table 8. Correlations between epistemic beliefs and ICT practices

Pearson correlations	General internet activity (8/9)	Versatile phone use (6/7)	Game playing (3/3)	Sharing pictures and files (3/3)	Digital news media use (4/4)	Blogging (3/3)
Omniscient authority (5/6)	−0.107	−0.045	0.052	−0.038	0.049	−0.133*
Certainty of knowledge (3/4)	−0.030	0.049	0.072	0.051	0.013	0.016
Structure of knowledge (7/8)	−0.030	0.071	0.095	0.089	0.044	0.011

Note: *Correlation is significant at the 0.05 level (two-tailed)

5. Discussion

5.1 Epistemic beliefs and internet reliance

The first research question aimed to explore a possible connection between young students' epistemic beliefs and their internet reliance. Our results exhibited weak or close to moderate

positive correlations between all epistemic belief dimensions and internet reliance (Table 6), indicating that a higher level of internet reliance goes hand in hand with a view of knowledge as certain, absolute and unchanging, as consisting of unambiguous, isolated bits and always being handed down by authority.

When discussing these correlations, it is important to bear in mind that the epistemic statements (Section 3.2.1) were not connected to any context or problem, and thus most students will have responded with their everyday life in mind. Instructing the students to base their responses on their everyday experiences from the past year was intended as a way of standardising their background. However, because about 44% had spent the previous year studying, 39% had worked and 16% reported doing "other", they will have interpreted the epistemic statements against slightly different backgrounds. The correlations between epistemic beliefs and internet reliance being only weak to moderate may be because of the respondents' varying interpretive backgrounds. Analysing the connections across sub-samples was, however, beyond the scope of this study (also see Section 5.5).

The correlation to omniscient authority raises several reflections. It may indicate a confusion between the information channel (the internet) and the actual source, or that the user does not pay much attention to the source. Perhaps more important, it suggests a trust in an algorithmic authority (Section 2.2) without awareness of the limitations, biases and intentions of that authority. Thus, the conclusion could be that some students regarded "the internet" itself as a knowledge authority, i.e. a trusted source of knowledge. Consequently, when believing in knowledge coming from authorities, there is less need for critical reading by oneself. When information sources are easy to access, the convenience may override critical scrutiny (cf. Alexander and DRLRL, 2012; Biddix *et al.*, 2011; Sundin *et al.*, 2017).

Building upon the concepts of search-ification of everyday life and mundane-ification of search (Sundin *et al.*, 2017), searching is often done without a clear instrumental purpose. In those situations, assessment of the results' credibility may become less important. The mundane-ification may entail that mundane practices are transferred also to searches that should be more goal-oriented. As a consequence, the user does not pay attention to credibility assessment although the requirements for information quality might be more rigorous, as e.g. in higher education. Further, by accepting the filtered and ranked search results, the user allows the search engine to act as a "proxy authority" although the original source has never authorised or assigned the search engine to act in that position. Should this "mundane search practice" be transferred from everyday life to higher education studies, it would not provide a good ground for scholarly practice. In higher education, problems discussed in studies are often complex, requiring more goal-oriented and by no means simple look-up searches. Various types of sources are available, but they often provide insufficient and even conflicting information that requires informed and task-dependent assessment of information credibility. Our material is not capable of indicating a change such as mundane-ification, but we deem it as important to acknowledge this potential risk.

The correlation between internet reliance and structure of knowledge may indicate that the ubiquitous access to information promotes a simplified world view: a belief that knowledge has a simple structure; things are black and white; and that problems have a simple and straightforward explanation. Search engines assess the relevance and rank the hits according to algorithms covert to the user (Hinman, 2008, p. 69; Simpson, 2012). The top of the list often contains simple explanations in the form of excerpts, "People also ask" compilations, and links to Wikipedia pages that contain only brief introductions to various topics that anyone can edit (Wikipedia, 2011). This may give the user the perception of knowledge being simple, or consolidate an existing perception.

The correlation to certainty of knowledge was less pronounced and a bit surprising. One would expect that those relying on internet-based sources would also regard knowledge as tentative and evolving, because internet sources are open for daily changes and updates. Considering the positive correlation between all epistemic belief dimensions and internet reliance (Table 6), one explanation could be that the belief in certain and unchanging knowledge is influenced by the belief in simply structured knowledge being handed down by some authority. Another explanation could be that, building upon the results by Muis *et al.* (2016), statements concerning certainty of knowledge may be especially difficult to respond to if they are not connected to any subject or context.

Altogether, the fact that all three epistemic belief dimensions correlate positively with internet reliance indicates that students with a high reliance on internet-based information tend to have epistemic beliefs, where they regard knowledge as certain, absolute and unchanging, as consisting of unambiguous, isolated bits and always being handed down by authority.

5.2 Internet reliance and information and communication technology practices

Although only weak correlations were observed between internet reliance and various dimensions of ICT practices, it is notable that in five out of six ICT practices, they are systematically positive. It seems that internet reliance is associated with the students' activity in all ICT practice profiles except with blogging. The connection to a general activity level seems coherent, but otherwise no conclusions can be drawn based on this material and without a connection to context.

5.3 Epistemic beliefs and information and communication technology practices

The common result in this comparison was that almost all pairs exhibited a non-existing correlation. The only exception was omniscient authority, exhibiting a very low and negative correlation with blogging. The anomaly in the overall trend raises a question: Are bloggers' mind-sets different from the other active ICT and internet users?

5.4 Reliability and validity considerations

In the current study, we were operating with three sets of units of analysis: epistemic belief dimensions, internet reliance and ICT practices. All units were based on questionnaire items and composed as computed subscale scores (Section 3.2).

The epistemic belief measures were based on previous instruments (Section 3.2.1). Most of the subscales that were created from the anticipated items proved good internal consistency, and the inter-dimension correlations appeared similar to the inter-factor correlations reported in previous studies (e.g. Otting *et al.*, 2010; Ståhl, 2019; Wood and Kardash, 2002, p. 252). This indicates that the epistemic belief measures used in this study are functional, also when used as computed subscale scores. However, from the certainty of knowledge subscale, two items were dropped, leaving only four items and a subscale with rather low internal consistency. This may indicate that when measuring certainty, the absence of a clear connection to domain or context will cause the responses to be based on a variety of interpretive backgrounds, which probably blurs the response patterns and thereby the covariances essential for internal consistency.

For the concept of internet reliance, there were no validated instruments available, but the items used to measure internet reliance were partly inspired by, and similar to, those used in previous studies (e.g. Bråten *et al.*, 2005; Strømsø and Bråten, 2010). The subscale, including all five anticipated items, also proved good internal consistency. Unfortunately,

the results regarding internet reliance are difficult to compare to previous research, because, to the best of the authors' knowledge, these kinds of comparisons have not been described.

For both the epistemic belief and internet reliance measures, the non-substantive "don't know" and "don't understand" response options will have contributed to the substantive responses expressing the respondents' true conception of each item.

As in the case regarding internet reliance, validated scales describing ICT practices were not available although the one we used as a starting point has been broadly applied (Section 3.2.3). It is, however, important to bear in mind that, because of the technological development – with new technologies continuously giving rise to new practices – a validated scale would very soon be inaccurate. In the current study, the scales described ICT practices in the contemporary internet, ICT and media context, and most subscales proved good internal consistency.

5.5 Contribution to the field of epistemic beliefs research

Research around epistemic belief dimensions has a long history, and although the several variants of self-report instruments have been criticised, the current study contributes by showing that at least initially, it can be informative to use surveys to measure epistemic belief dimensions on a general level and in relation to other constructs. For future purposes, self-report surveys will not be sufficient alone to study and enhance our conceptions of epistemic beliefs but, instead, a multiple methods approach will be required. The use of qualitative methods, including, in-depth collection and analysis of data requires considerable resources (cf. Muis *et al.*, 2016) and were not applicable in this study.

The important results of this study are the positive correlations between internet reliance and all three dimensions of epistemic beliefs. The findings bring into light that within epistemic beliefs research, algorithmic authority has been a neglected concept. The results indicate that, when measuring the dimension of omniscient authority, the possibility of non-human authority needs to be acknowledged. This poses quite new challenges for setting the context and – if using self-reporting – for constructing the instrument.

Referring to potential risks (Section 2.2), when measuring the belief in authority, future research needs to acknowledge the challenge in distinguishing if and when the informant refers to an actual human or institutional authority or when the referred authority is an algorithmic authority. Further, measurement needs to include an assessment of whether the user is able to identify and distinguish between human and algorithmic authority. In this context, we may note that decision support systems already build upon algorithmic authority, and with the development of artificial intelligence, their occurrence and significance will increase.

Sundin *et al.* (2017) highlight that retrieving information from the internet is no longer a goal-oriented task but, instead, an integral part of everyday activities and practices. Thus, it becomes even more obvious that, in future studies, all three issues (epistemic beliefs; how everyday search practices are transferred to study contexts; the connection between Internet reliance and epistemic beliefs) should be measured in relation to domain, context and task at hand, as suggested by Elby and Hammer (2010, pp. 415, 431) and Alexander and DRLRL (2012). The discussion around the certainty dimension (Section 5.1) may illustrate this. The items included in this dimension (Table 2) are rather abstract phrasings, and because the statements were not connected to any context, they were apparently challenging. The fact that two of the items within the certainty dimension exhibited high portions of "don't know" and "don't understand" responses is an indication in this direction.

Not connecting the survey to domain, context or problem may be regarded as a weakness of this study. On the other hand, the fact that we identified correlations between internet

reliance and epistemic beliefs while presenting the statements in a general context suggests that, if delimiting the setting into a defined domain, context or problem, the correlations will appear differently, probably more distinct [cf. the inter-domain correlations presented by Muis *et al.* (2016)].

5.6 Consequences for educational practice

The results of the current study indicate that a higher level of reliance in internet-based information goes hand in hand with a view of knowledge as certain, absolute and unchanging, as consisting of unambiguous, isolated bits and always being handed down by authority. Considering the ubiquitous presence of the internet, educational practitioners at all levels need to relate to the multiplicity of ubiquitous information, and consider how to support pupils and students in building their knowledge on true and valid information and in avoiding misinformation and disinformation.

Sundin *et al.* (2017) highlight that the convenient and ubiquitous access to information is causing a total change of epistemic practices. Connecting back to potential risks mentioned earlier (Section 2.2), we believe that changed epistemic practices and the ignorance of algorithmic authority together with the findings of this study illustrate the potential risks of everyday search behaviour being transferred into the higher education context, where critical review and credibility assessment are paramount. Considering the search engines' personalisation as a process of exclusion by omission, it is obvious that the more one uses a search engine and relies on the information offered by it, the bigger the risk of being trapped in an epistemic bubble (Nguyen, 2020). Consequently, students within higher education should not (be allowed to) build their knowledge upon information where pieces have been omitted by some covert algorithm.

As shown in several studies, epistemic beliefs are susceptible to change (e.g. Ferguson and Bråten, 2013; Kienhues, 2016; Mierwald *et al.*, 2018; Muis and Duffy, 2013) and, thus, the goal of education should be to develop students' epistemic awareness. To this end, awareness of epistemic practices and algorithmic vs human authorities could act as useful concepts and tools in developing students' information literacies.

Building upon Simon's (2010) view of search engines as epistemic agents, we suggest that distinguishing epistemic agents, processes and content might be a useful tool when supporting students' information and digital literacies. Trust (here interchangeable with reliance) appears crucial. Does the user identify whether the epistemic agent he/she encounters is human or non-human and then, on what grounds does he/she place trust in this agent? Is placing trust different in case of human and non-human agents? Further, on what grounds does he/she place trust in the epistemic process of searching and choosing a piece of information before finally trusting the actual content?

To develop students' information and epistemic practices, this conceptualisation could serve both structuring the challenge and also setting up domain-, context- and task-oriented measures, exercises and tests.

6. Conclusions

The results of this study open up several approaches for research about epistemic beliefs in relation to internet-based information, and the field appears as rather complex. Our results, limited to identifying a connection between internet reliance and epistemic beliefs, are essential steps that pave the way for later comparisons of changes over time or across other background factors.

The results regarding the first research question indicate a connection between an individual's epistemic beliefs and internet reliance. A person holding epistemic beliefs about

knowledge being certain, absolute and unchanging, being simply structured and unambiguous, isolated bits and being mainly handed down by an authority will also hold a higher degree of reliance towards internet-based information.

The results regarding the two other research questions did not exhibit convincing connections, which may indicate a methodological problem. The research methods require development such that both epistemic beliefs and internet reliance should be measured in relation to domain, context and task. Another methodological conclusion is that measuring the dimension of omniscient authority will need to acknowledge both human and algorithmic authority and distinguish between them.

The results of this study contribute to the discussion regarding the ubiquitous access to information; the ways users search and trust information; and the consequences for knowledge building and learning within higher education and research (cf. Bhatt and MacKenzie, 2019; Sahut and Tricot, 2017). Above all, the results indicate that the issue is relevant and justified, the research field is complex and that further investigation is urgent.

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