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

Tore Ståhl
Faculty of Education and Culture, University of Tampere, Tampere, Finland and Department of Culture and Media, Arcada University of Applied Sciences, Helsinki, Finland

Eero Sormunen
Faculty of Information Technology and Communication Sciences, Tampere University, Tampere, Finland, and

Marita Mäkinen
Faculty of Education and Culture, Tampere University, Tampere, Finland

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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; Ståhl, 2017; Litt, 2013).

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*?

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

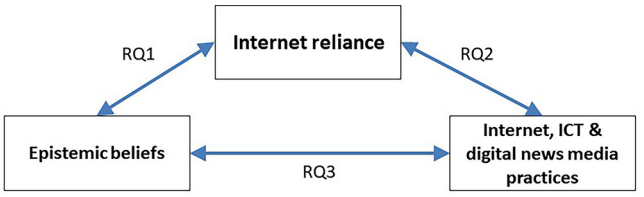

Figure 1.
Research questions

health, welfare and culture to business and engineering. About 86% of the students were domestic and 14% represented 32 other nationalities (Table 1).

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

Table 1. Sample distribution across study programmes

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

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			–

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

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.

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.

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

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

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.

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 $|\text{kurtosis}| \leq 1$ and $|\text{skewness}| \leq 1$ 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.
- 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

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

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).

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).

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).

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),

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

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

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).

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)

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)

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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About the authors

Tore Ståhl holds a MEd degree and is enrolled as a PhD student at Tampere University, Faculty of Education and Culture. The topic for his dissertation is "Epistemic beliefs among the Net Generation". During his career, he has developed online teaching and learning at Arcada University of Applied Sciences, where he is currently assigned as a researcher in education. Tore Ståhl is the corresponding author and can be contacted at: tore.stahl@tuni.fi

Eero Sormunen is a Professor Emeritus in the Faculty of Information Technology and Communication Sciences, Tampere University, Finland. His research focuses on information literacy and learning, and task-based information retrieval.

Marita Mäkinen is a Professor of education (teacher education) at the Faculty of Education and Culture, Tampere University, Finland. Her research interests include multiliteracies, teacher education, inclusive education and teaching and learning in higher education.

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