

The role of educational context in beliefs about knowledge, information, and truth: an exploratory study

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Received: 17 February 2017 / Revised: 10 November 2017 / Accepted: 14 November 2017 /
Published online: 1 December 2017

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of Springer Nature 2017, corrected publication December/2017

Abstract Beliefs about knowledge have been found to relate to a variety of student outcomes and to vary across educational domains and instructional contexts. However, there are limited data on students' beliefs about information and truth, vis-à-vis knowledge (i.e., epistemic beliefs) and how these beliefs differ across instructional settings. Undergraduates from two educational contexts, in the USA ($n = 240$) and the Netherlands ($n = 72$), participated in this study. While students in the USA were enrolled primarily in lecture and discussion classes, students in the Netherlands followed a problem-based learning curriculum. Beliefs about knowledge, information, and truth and their interrelations were examined across these two contexts through graphical and written justification tasks. Results from this exploratory study indicate that Dutch students were more likely than American students to depict knowledge, information, and truth as subjective and to define knowledge and information as synonymous. Commonalities and differences associated with educational backgrounds are considered in relation to instructional implications.

Keywords Knowledge · Information · Truth · Epistemic beliefs · Educational context

An earlier version of this paper contained incorrect tables due to a publication error. Tables were corrected in this version.

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The role of educational context in beliefs about knowledge, information, and truth

Epistemic beliefs, students' beliefs about the nature of knowledge and knowing, have been described as the "lens through which individuals interpret information, set standards, and decide on an appropriate course of action" (Buehl and Alexander 2001). Given the importance of such a lens, the relative sophistication of students' epistemic beliefs has been widely regarded as a critical marker of academic development (Hofer and Pintrich 1997; Jensen et al. 2015; Palmer and Marra 2004) and students' educational experiences have been examined to determine the extent to which they support the development of epistemic beliefs (Karttinen-Koutaniemi and Lindblom-Ylänne 2008; Perry 1970; Rodríguez and Cano 2007). Yet, educational experiences are not all equivalent in their facilitation of epistemic belief development (e.g., Hofer 2004; Hofer and Pintrich 1997).

One area of focus has been on how the beliefs of today's undergraduates are impacted by their learning in the digital age, characterized, in part, by the easy access to an overabundance of information afforded by the Internet (Lankshear et al. 1996). Many scholars have examined beliefs in the digital age by investigating the association between epistemic beliefs and students' behaviors and performance in Internet contexts (e.g., Bråten et al. 2011; Kammerer and Gerjets 2012; Mason et al. 2011). We adopt a different perspective. Along with other scholars (Lankshear et al. 1996), we argue that to understand undergraduates' beliefs in the digital age, it is insufficient to examine traditional notions of epistemic beliefs as associated with new types of behaviors (e.g., searching for information online). We propose that to understand beliefs in the digital age, it is necessary to examine students' conceptions of *information* and *truth* as they relate to the more traditional construct of *knowledge* (Alexander et al. 2012). The need for an expanded approach examining the core constructs that constitute students' epistemic beliefs is due to challenges presented within digital environments. Such challenges include the increased availability of information online and the increased need to verify the accuracy of information, as well evidence that students may have undue trust in online information (Flanagin and Metzger 2000, 2007; Lankshear et al. 2000). Heretofore, we will refer to students' beliefs about knowledge (K), information (I), and truth (T) and their interrelation as KIT beliefs. In this study, we were interested in students' KIT beliefs and exploring the extent to which these beliefs may differ across educational contexts.

Conceptions of knowledge, information, and truth in the digital age

Although beliefs about knowledge have been investigated for more than 40 years (e.g., Perry 1970), students' conceptions of what *information* or *truth* may mean have remained underexplored in the literature (Alexander et al. 2012). Certain exceptions do exist. For one, Lankshear et al. (1996) consider knowledge and epistemic beliefs as they relate to information and to truth, particularly online, and argue for the development of a theory that brings together notions of knowledge, information, and truth. More recently, Lankshear et al. (2000) have argued that issues of epistemology and traditional notions of knowledge are incomplete given the demands on today's students brought on by Internet use and the need to process a "superabundance" of information (p. 26). These researchers have called for the development of a *digital epistemology* (Lankshear 2003) or what Thagard (1997) termed *Internet epistemology*. Expanding conceptualizations of students' beliefs involves considering the relations among conceptions of knowledge and information as well as how understandings of truth may

be related to these both. Prior studies of KIT beliefs (Alexander et al. 2012; Grossnickle et al. 2015) have identified reliable patterns in students' definitions of these constructs and depictions of the relations among KIT terms and accompanying justifications.

Knowledge and information Within digital contexts, there appears to be little distinguishing knowledge and information (Kammerer et al. 2015; Mason et al. 2014; Walraven et al. 2013). Researchers in the fields of information science and knowledge management have frequently defined knowledge in relation to information (Mingers 2008; Rowley 2007). At the same time, *knowledge* and *information* have also been differentiated, including constructivist definitions that consider knowledge to be the product of information that has been transformed or converted (Ackoff 1989; Kettinger and Li 2010) and information processing theories that view knowledge as information that has been processed and encoded (e.g., Newell and Simon 1972). Such conceptions align with students' KIT beliefs, as reported in prior work. Specifically, some students have been found to express beliefs about knowledge as processed or stored information (Alexander et al. 2012).

Truth in relation to knowledge and information In educational research, scholars have extensively explored definitions of knowledge (Alexander et al. 1991; Kitchener and King 1990) and have traditionally aligned their understandings with Plato's conception of knowledge as justified true beliefs (Chisholm 1977; Gettier 1963). Similarly, empirical investigations of epistemic beliefs have included questions tapping students' beliefs about the truthfulness of knowledge (e.g., Brownlee et al. 2009). In our own work examining KIT beliefs, students have commonly associated truth with knowledge and information (Alexander et al. 2012). Specifically, across six KIT belief profiles identified, students most commonly saw the relation among KIT constructs as procedural or process oriented. As such, they regarded information and truth as combining to establish knowledge, or knowledge and information as combining to establish truth. Another subset of students described the terms as either generally related or discussed these constructs in terms of their relative importance or their relative amount in the world. Additional profiles included a smaller subset of students who depicted knowledge or information as subjective or truth as subjective.

While the role of truth in the conceptualization of knowledge has been preserved in digital contexts, truth has not been identified as a critical feature of information in the same way (Gerjets et al. 2011; Lankshear et al. 2000). Nevertheless, students' ratings of information *plausibility* (Lombardi and Sinatra 2012), *credibility* (Metzger et al. 2003), and *believability* (Vader et al. 2011) have been examined either on their own or in association with students' prior knowledge (e.g., Flanagin and Metzger 2007). Such ratings have been considered to reflect students' determinations of the *truthfulness* of information based on some external (e.g., authoritativeness) or personal (e.g., plausibility) standard.

Beliefs about information and truth have infrequently been examined in relation to beliefs about knowledge, although when given the opportunity to consider these three constructs together, students most frequently described KIT terms as related (Alexander et al. 2012; Grossnickle et al. 2015). In one example, Mason et al. (2010) examined how information and truth related to students' beliefs about knowledge (i.e., epistemic beliefs) as manifested through think-aloud utterances produced during Internet search. Students ranged from considering knowledge to be a *collection of information*, to considering knowledge to be the *comparison of information* originating from multiple sources, to knowledge being a *shared scientific answer*: a coding scheme reflecting assumptions about the relation between

knowledge and information and the standards needed for information to be considered truthful or accurate. Given these findings, it is important to further examine beliefs about information and truth as they relate to knowledge, and to investigate whether KIT beliefs shift over time and due to educational experiences in ways similar to, or different from, epistemic beliefs.

Beliefs across educational contexts

Important for researchers and educators seeking to support the development of competent beliefs is an understanding of how beliefs are shaped by the contexts in which students are educated (Karttinen-Koutaniemi and Lindblom-Ylänne 2008; Palmer and Marra 2004; Tsai 2000), arising from the intersection of culture and academic practice. The specifics of educational contexts within broader cultural contexts have been identified as important. For instance, Maggioni et al. (2006) found differences among students in Italy, whose beliefs in the degree to which *knowledge* and *beliefs* overlapped differed by high-school curricular program. Further, in an examination of two colleges differing in educational context but similar in overarching national cultures (i.e., Canada and the USA), Muis and Sinatra (2008) identified differences in the degree to which students endorsed constructivist beliefs based on course design differences across the two universities. Of additional importance to the present study is evidence that first- and fourth-year Dutch undergraduates differed in their beliefs about knowing and learning based on extended engagement with problem-based learning (PBL; Otting et al. 2010), one educational context investigated in the present study. These findings emphasize the need to consider the ways in which perceptions of knowledge—as well as the related constructs of information and truth—vary from one context to another, keeping in mind that certain contextual influences migrate across sociocultural and educational borders (Kim et al. 2011; Norris 2003).

The present study

Given that limited research has addressed students' beliefs about information and truth in relation to their beliefs about knowledge, we conducted an exploratory study to examine whether students' beliefs differed across two contexts, differing in both culture and instructional method. The purpose of the present study is twofold. First, this study examines the beliefs of students in the digital age. Building on earlier work (Alexander et al. 2012; Grossnickle et al. 2015), we investigated not only students' beliefs about knowledge but also their conceptions of information and truth and the interrelation among these three constructs. Given the importance of evaluating information and making decisions about truthfulness in Internet contexts, the inclusion of *information* and *truth* alongside beliefs about knowledge is necessary for gaining a deeper understanding of how undergraduate students navigate digital academic environments. Second, this study is an exploratory investigation of the manifestation of such beliefs across two contexts, differing in both culture and curriculum. In the present study, students in the US sample were enrolled in large lecture-based courses, where class readings came primarily from a textbook, while students in the Netherlands sample were exposed to a PBL curriculum, wherein they were asked to independently find readings relevant to course content. In this study, the manifestation of KIT beliefs was expected to differ across cultural and educational settings in the USA and the Netherlands. However, specific differences were not identified, due to the exploratory nature of this study. Nonetheless, finding

differences across contexts in this exploratory study would provide a basis for future investigations to disentangle the effects of educational and cultural context on KIT beliefs.

To address these questions, the present study adopts a novel methodological approach to examining students' conceptions of abstract KIT constructs, considering how students graphically represent these, relate them to one another, and define them. Specifically, we sought to address the following research questions:

1. How do undergraduate students at two different universities (i.e., different educational contexts) define the constructs of knowledge, information, and truth? Do these definitions differ depending on the undergraduates' educational and cultural context?
2. How do undergraduate students at two different universities (i.e., different educational contexts) conceptualize the relations among knowledge, information, and truth? Do these relations differ according to undergraduates' educational and cultural context?

Method

Participants

Three hundred and twelve participants were included in the study. There were 240 participants from a large, mid-Atlantic university in the USA and 72 from a large urban university in the Netherlands. Students were recruited from human development and educational psychology classes in the USA and psychology classes in the Netherlands. As displayed in Table 1, both the US and Dutch samples were predominantly female (82.5 and 84.7%, respectively), generally around 20 years of age (20.85 and 20.31%, respectively), and White (61.7 and 68.1%, respectively).

Educational context

US undergraduates were enrolled in human development or educational psychology courses at a large mid-Atlantic university. For each class, students attended lectures for 2 to 3 h a week, varying in size from 35 to 200 students. The instructor was responsible for the selection of content and content delivery in these courses. Typically, these classes required students to listen and take notes on the delivered content, although there were opportunities for discussion, active learning, small group activities, and other format variations at the discretion of the instructor. Additionally, larger classes were supplemented with weekly discussion sections to either introduce new material or to elaborate on information from the lectures. As part of the learning process, these students were typically assigned texts and readings for particular class sessions. Although textbooks were heavily utilized, there were some opportunities for students to select their own readings for course papers and assignments. Courses typically took place during two 15-week semesters per academic year.

Our sample of Dutch students was undergraduate psychology students studying at a large urban university. The educational context for Dutch students was comparatively different on a number of dimensions. For one, classes tended to be smaller in size and all followed a PBL format. In PBL, the learning process begins with a complex, ill-structured problem describing one or more observable phenomena or events (Barrows 1996; Schmidt 1983). Students then discuss these problems in small groups (i.e., 10 to 12 students), based on their existing

Table 1 Demographic information by country

	The USA (<i>n</i> = 240)		The Netherlands (<i>n</i> = 72)	
	<i>N</i>	%	<i>N</i>	%
Gender				
Male	42	17.5	11	15.3
Female	198	82.5	61	84.7
Native English speaker				
Yes	221	92.1	6	8.3
No	19	7.9	66	91.7
Ethnicity				
White	148	61.7	49	68.1
Black	32	13.3	4	5.6
Asian	38	15.8	0	0
Hispanic	11	4.6	1	1.4
Other	11	4.6	18	25.0
Major				
Education	38	15.9	0	0
Psychology	29	12.1	69	95.8
Other social science	151	63.2	0	0
Humanities	8	3.3	0	0
Natural science	12	5.0	0	0
Age	<i>M</i> = 20.85, <i>SD</i> = 2.32		<i>M</i> = 20.31, <i>SD</i> = 2.26	

Percents for major do not add up to 100 because two students in the USA and three students in the Netherlands did not report their major

knowledge and experience before receiving other curricular input. In groups, they try to construct an understanding of the problem and discuss possible explanations or solutions (i.e., prediscussion or brainstorm). Since prior knowledge is limited, students formulate learning issues (i.e., questions) that become the basis of their self-directed self-study activities. Subsequently, students select pertinent resources (e.g., journal articles and chapters) about the topic, plan their study activities to optimally prepare themselves for the next group meeting, and assess whether their self-study activities were sufficient to fully understand the subject matter introduced in the problem (Wijnia et al. 2011). During the group meetings, a tutor is present, but he or she only has a guiding, facilitative role. The tutorial groups constitute the main educational activity in a PBL curriculum and the number of lectures is limited. In the program under study, eight courses, each lasting 5 weeks, were offered sequentially to the students, with a course test administered at the end.

Measures

Graphic representation and verbal justification task First, we asked participants to construct a visual representation of their perspectives of the interrelation among *knowledge*, *information*, and *truth* using drawing tools provided in an online environment (see Fig. 1). Participants were directed to choose among three sizes of circles for each of the three concepts and to drag and drop the circles into a designated box to represent their conception of the relation between *knowledge*, *information*, and *truth*; participants could select any size circles and position them in any way. The graphic activity was intended to stimulate students' thinking about these abstract concepts, without the hindrance of trying to explain their conception linguistically. In this manner, the graphic served as a prompt. The participants

DIRECTIONS: We are interested in how you think knowledge (K), information (I), and truth (T) are related.

Drag **one** of each of the circles marked K, I, and T from the shape bank into the box to the right and create a representation of this relation.

You may choose any of the available sizes and position them in any way, using all the time you need for this task.

You will have a chance to explain and elaborate on your graphic in writing.

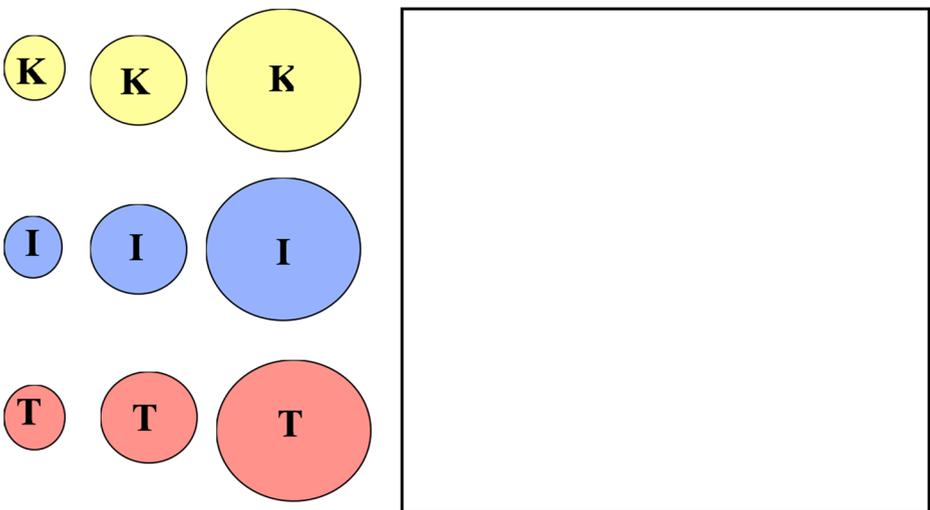


Fig. 1 Screenshot of knowledge, information, and truth graphics task

were then asked to justify their particular representation of the relation between knowledge, information, and truth.

We analyzed the written and verbal descriptions based on previously conceived profiles (Alexander et al. 2012), at the same time allowing for additional categories to emerge. Categories were not exclusive and we allowed individuals' descriptions to be coded into multiple categories. A random sample of 13.2% of the 227 responses remaining after deleting inconsistencies were coded by two of the authors with 93.0% exact agreement ($\kappa = 0.92$). Disagreements were resolved through discussion. Table 2 includes the coding scheme along with sample justifications.

Definitional task After creating a graphic depiction of the relations among knowledge, information, and truth, participants were asked to define each of the terms: (a) “What does the term *knowledge* mean to you?”; (b) “What does the term *information* mean to you?”; and (c) “What does the term *truth* mean to you?”

Students' definitions for knowledge, information, and truth were coded based on a typological analysis of the categories that emerged based on students' definitions of each construct (see Tables 3,

Table 2 Examples of definition coding

Category	Example
Knowledge	
Learning/derived from experience	"It is what you know and learned in many different ways like in lectures, books, and experiences."
Information	"Knowledge is the information someone has about a certain subject." "Amount of information you know"
Stored information	"Information stored in an individual's memory" "Knowledge is all the information in your long term memory that you can recall at any time"
Processed information	"I think knowledge is how a person uses and applies information in meaningful ways" "Processed information that can be used and applied outside of the situation in which it was gathered"
Justified true beliefs/substantiated	"Proven facts/truth that is known" "Ideas you know and believe personally in your mind"
Intelligence/wisdom	"Intelligence" "Being wise. Not just in education and books but in giving advise."
Recursive	"What you know about the world" "What a person knows"
Other	"The perceptual interplay of information and reality"
Information	
Synonymous with data/facts	"Information is simply hard data or facts." "Information is statements of known facts."
Data transformed	"Information is something you get out of books, tv, from other people, etc." "Information is any input that one must comprehend"
Synonymous with knowledge	"Knowing a lot." "Information is for me that you know something about a subject."
Aspect of knowledge	"Things that you put together to form fact, opinions...etc. Eventually mold this into knowledge."
Requiring truth	"Facts about things that actually happened or are true." "Information is factual evidence stemming from the truth."
Other	"Information could be defined as of the world; coming from the enemy in the form of feelings or thoughts."
Truth	
Real/factual	"Concrete facts" "Truth is actuality. What is real"
Substantiated/ proven	"Something that can be proven and substantiated, that is reliable"
Subjective	"Truth can mean different things to different people" "Truth is different in each individual. Truth is what each person believes in and what each person thinks is real. Truth to one person could be untrue to another."
Truthfulness/ moral character	"To me truth does not mean fact, but rather it has more to do with character. Being truthful to friends and family is the most important thing."
Related to knowledge and information	"Understanding and comprehension of information and knowledge over time" "Information must be truthful to get good new knowledge."
Recursive	"Truth is simply that; truth. It is what is true amongst all of the information."
Other	"What the topic or material inevitably encompasses"

4, and 5). Unlike the coding for the graphic and verbal justification task, definitions were coded into mutually exclusive categories. Two raters independently coded a portion of the definitions of knowledge ($n = 45$, 14.42%), information ($N = 60$, 19.23%), and truth ($N = 50$, 16.03%). High

Table 3 Knowledge definitions by country

Category	The USA	The Netherlands	Total
Learning/derived from experience	35.4% (<i>n</i> = 85)	31.9% (<i>n</i> = 23)	34.6% (<i>n</i> = 108)
Information	7.9% (<i>n</i> = 19)	13.9% (<i>n</i> = 10)	9.3% (<i>n</i> = 29)
Stored information	14.2% (<i>n</i> = 34)	9.7% (<i>n</i> = 7)	13.1% (<i>n</i> = 41)
Processed information	16.7% (<i>n</i> = 40)	6.9% (<i>n</i> = 5)	14.45% (<i>n</i> = 45)
Justified true beliefs/substantiated	6.7% (<i>n</i> = 16)	6.9% (<i>n</i> = 5)	6.7% (<i>n</i> = 21)
Intelligence/wisdom	2.9% (<i>n</i> = 7)	6.9% (<i>n</i> = 5)	3.8% (<i>n</i> = 12)
Recursive	12.1% (<i>n</i> = 29)	18.1% (<i>n</i> = 13)	13.5% (<i>n</i> = 42)
Other	4.2% (<i>n</i> = 10)	5.6% (<i>n</i> = 4)	4.5% (<i>n</i> = 14)

interrater agreement was found for each of the terms (knowledge 86.67%, $\kappa = 0.85$; information 83.33%, $\kappa = 0.80$; truth 80.00%, $\kappa = 0.77$).

The graphic representation and verbal justification task as well as the definitions task represent novel ways of assessing learners' epistemic beliefs, which have previously been investigated almost exclusively through questionnaire studies (Greene et al. 2008; Schommer 1990). This methodological approach was selected for three primary reasons. First, we considered the complexity of KIT beliefs and their interrelation to be unsuitable for assessment via questionnaire. Second, due to the exploratory nature of this study, a more open-ended task, beyond a questionnaire format, was needed. Third, elements of the task were specifically designed to get at learners' folk or lay theories of these constructs. Specifically, the graphics task was used as a simple and engaging method of eliciting learners' conception of the interrelation among these constructs. The open-ended definitions task was designed to assess learners' understanding of these constructs, sans biasing or value-laden language.

Table 4 Information definitions by country

Category	The USA	The Netherlands	Total
Synonymous with data/facts	41.7%* (<i>n</i> = 100)	19.4%* (<i>n</i> = 14)	36.5% (<i>n</i> = 114)
Data transformed	27.9% (<i>n</i> = 67)	30.6% (<i>n</i> = 22)	28.5% (<i>n</i> = 89)
Synonymous with knowledge	7.1%* (<i>n</i> = 17)	20.8%* (<i>n</i> = 15)	10.3% (<i>n</i> = 32)
Aspect of knowledge	15.8% (<i>n</i> = 38)	23.6% (<i>n</i> = 17)	17.6% (<i>n</i> = 55)
Requiring truth	1.7% (<i>n</i> = 4)	0.0% (<i>n</i> = 0)	1.3% (<i>n</i> = 4)
Other	5.8% (<i>n</i> = 14)	5.6% (<i>n</i> = 4)	5.8% (<i>n</i> = 18)

*Significant differences by educational context, determined based on standardized residuals

Table 5 Truth definitions by country

Category	The USA	The Netherlands	Total
Real/factual	56.7% (<i>n</i> = 136)	55.6% (<i>n</i> = 40)	56.4% (<i>n</i> = 176)
Substantiated/proven	23.8%* (<i>n</i> = 57)	15.3%* (<i>n</i> = 11)	21.8% (<i>n</i> = 68)
Subjective	10.8% (<i>n</i> = 26)	11.1% (<i>n</i> = 8)	10.9% (<i>n</i> = 34)
Truthfulness/moral character	3.3% (<i>n</i> = 8)	2.8% (<i>n</i> = 2)	3.2% (<i>n</i> = 10)
Related to knowledge and information	1.2%* (<i>n</i> = 3)	9.7%* (<i>n</i> = 7)	3.2% (<i>n</i> = 10)
Recursive	1.7% (<i>n</i> = 4)	2.8% (<i>n</i> = 2)	1.9% (<i>n</i> = 6)
Other	2.5% (<i>n</i> = 6)	2.8% (<i>n</i> = 2)	2.6% (<i>n</i> = 8)

*Significant differences by educational context, determined based on standardized residuals

Procedure

After providing consent and completing a brief demographics questionnaire, participants were directed to complete the graphics and justification task and the definitional task. For both US and Dutch undergraduates, all tasks were presented in English. Understandably, while relatively few Dutch respondents had English as their native language, all reported being able to deal with the comprehension demands of the experimental task. In fact, within the Dutch educational context, all learning materials (e.g., books, articles) are presented in English and many educational activities take place in English. Thus, the Dutch students in this study were very well familiar with reading and expressing themselves in English. Dutch students were provided with the opportunity to compose their responses in English; however, only seven students elected to do so. Responses in Dutch were translated to English prior to analysis.

Results

Definitions of knowledge, information, and truth across educational contexts

When presenting the results, the groups are referred to according to the country of schooling (i.e., USA or the Netherlands). This is done to simplify the description of the results; however, it is important to note that each groups' educational context is defined by distinct cultural, instructional, and educational experiences.

Knowledge definitions Students' definitions of knowledge, summarized in Table 3, fell into seven categories. The most commonly reported category included definitions of knowledge as *learned or derived from experience* (34.6%, *n* = 108). These students' definitions described knowledge as internalized from external sources or experiences, as explained by one participant: "It is what you know and learned in many different ways like in lectures, books, and experiences." Other students described knowledge as information made personal in some way. This included students who described knowledge as *stored information* able to be recalled (13.1%, *n* = 41), and

processed information (14.4%, $n = 45$), such as “processed information that can be used and applied outside of the situation in which it was gathered.” Other definitions included knowledge as *synonymous with information* (9.3%, $n = 29$). In the fifth category, were participants who adopted a more Platonic view of knowledge as *justified true beliefs* or as substantiated in some way (6.7%, $n = 21$), such as “the combination of information and truth to come up with your own ideas, stances, and opinions on matters.” Participants also described knowledge as *intelligence or wisdom* (3.8%, $n = 12$) or recursively (13.5%, $n = 42$).

Knowledge definitions across educational context In defining knowledge, the most popular characterization portrayed knowledge as *learned or derived from experience* (see Table 3). This held for students in both the USA (35.4%, $n = 85$) and the Netherlands (31.9%, $n = 23$). For US students, the second most popular definition for knowledge was a conception of knowledge as *processed information* (16.7%, $n = 40$). However, this type of definition was favored by only 6.9% of Dutch students ($n = 5$). In the Netherlands, the second most popular definition was a *recursive* one, defining knowledge as “knowing.” Participants in the Netherlands defined knowledge recursively in 18.1% ($n = 13$) of cases, as compared to 12.1% ($n = 29$) of US participants.

A cross tabulation analysis was run to determine if students’ definitions of knowledge differed significantly by educational context. However, the overall chi-square test of independence was not significant, $\chi^2(7) = 10.83$, $p = 0.15$.

Information definitions Students’ definitions of information, displayed in Table 4, were classified into five groups (Alexander et al. 2012). In the most commonly reported category were participants who defined information as *synonymous with facts or data* (36.5%, $n = 114$). In the second category were participants who also related their definitions of information to facts and data. However, these respondents viewed information as *data transformed* (28.5%, $n = 89$). This transformation could have been either externally or socially performed, by a book or a teacher, or internally transformed, by the individual. Some participants also defined information as *synonymous with knowledge* (10.3%, $n = 32$) or as an *aspect of knowledge* (17.6%, $n = 55$). Finally, some regarded information as *requiring truth* or substantiation (1.3%, $n = 4$), such as “factual evidence, stemming from the truth.”

Information definitions across educational contexts The most popular definition offered by the US sample was information as synonymous with facts or data (see Table 4). This was the case for 41.7% ($n = 100$) of US students, but only 19.4% of Dutch participants ($n = 14$). The second most common definition of information was an understanding of information as data transformed (Netherlands 30.6%, $n = 22$; USA 27.9%, $n = 67$). In the Netherlands, information was commonly defined as an aspect of knowledge (23.6%, $n = 17$), but only 15.8% ($n = 38$) of US participants defined information in this way. Additionally, in the Netherlands, 20.8% ($n = 15$) of participants used the terms information and knowledge interchangeably, while only 7.1% ($n = 17$) of participants in the USA defined information in this manner.

A chi-square test of association was run to determine if there were differences in the definitions offered by US as compared to Dutch university students. The overall chi-square test was significant, $\chi^2(5) = 20.94$, $p < 0.01$. An examination of the standardized residuals demonstrated that students in the Netherlands were significantly more likely than their American counterparts to define information as being synonymous with knowledge. In the USA, 7.1% ($n = 17$) of students used the terms of information and knowledge interchangeably, compared

to 20.8% ($n = 15$) of students in the Netherlands. Participants in the Netherlands were also significantly less likely to define information as being facts or data (USA 41.7%, $n = 100$; Netherlands 19.4%, $n = 14$).

Truth definitions Five definitions for the construct of truth were identified a priori, stemming from writings in philosophy and psychology (e.g., Blanshard 2002; Davidson 1996; Hesse 1980; James 1907; O'Connor 1975), and content analysis revealed an additional category (i.e., *truthfulness/moral character*; see Table 5). In the first and most commonly reported category, participants defined truth as *real or factual* (56.4%, $n = 176$). Participants also described truth as *substantiated facts* or information that is proven or supported by evidence (21.8%, $n = 68$), describing truth as, “something that can be proven and substantiated, that is reliable.” In contrast, some students discussed truth as *subjective* (10.9%, $n = 34$) and described truth as varying by context, as individually constructed, or as open to individual interpretation (e.g., “Truth is what each person believes in and what each person thinks is real. Truth to one person could be untrue to another”). A small proportion of students described truth as *truthfulness* or related to *moral character* (3.2%, $n = 10$, or as *related to knowledge and information* (3.2%, $n = 10$). There were also participants who *recursively* defined truth (1.9%, $n = 6$) as well as definitions fitting into an *other* category.

Truth definitions across educational contexts In defining truth, the most popular definition put forth by students in both the USA (56.7%, $n = 136$) and the Netherlands (55.6%, $n = 40$) was truth as a fact or coinciding with facts or reality (see Table 5). This conceptualization was followed in popularity by one in which students defined truth in a manner consistent with the substantiated facts category, that is, discussing truth in terms of what can be proven or justified (USA 23.8%, $n = 57$; Netherlands 15.3%, $n = 11$).

A chi-square test of independence was run to determine if there were differences by country in students' definitions of truth. The overall chi-square test was statistically significant, $\chi^2(6) = 14.67$, $p < 0.05$. An examination of the standardized residuals determined that participants in the Netherlands (9.7%, $n = 7$) were significantly more likely than their US counterparts (1.2%, $n = 3$) to describe truth as related to knowledge and information. For the US sample, participants were more likely to describe truth as information that is substantiated or proven (23.8%, $n = 57$), as compared to participants in the Netherlands (15.3%, $n = 11$).

Relations among knowledge, information, and truth across educational contexts

Students' depictions and descriptions of the interrelations of the constructs of knowledge, information, and truth were coded into 10 categories (see Table 2), including six major a priori categories and four additional categories developed throughout the coding process.

Description of categories Participants' responses were coded for membership in the *truth establishment* category ($n = 75$, 24.04%) if their description focused on the formation, establishment, or existence of truth through knowledge and information (e.g., “The truth is between

knowledge and information because you need knowledge to figure out the truth. And you need information to gain knowledge”). Similarly, participants were marked for membership in the *knowledge establishment* category ($n = 63, 20.19\%$) if their responses dealt with the formation, establishment, or existence of knowledge via truth and information. These individuals considered knowledge to be the combination of or result of truth and information or the point at which truth and information intersected. Comparatively, responses in the *relative relation* category ($n = 124, 39.74\%$) focused on the relative amount of knowledge, information, and truth there is in the world (or in people), or on their relative importance, such as: “Both knowledge and information are infinite therefore I have chosen the large circles. But only a small part of that knowledge and information is the truth.”

Descriptions were categorized as *interrelated* ($n = 51, 16.35\%$) if they discussed the interrelation of the three terms with little other description. The *subjectivity of information or knowledge* category ($n = 112, 35.90\%$) included responses that described knowledge or information as either only partially true or as subjective and open to personal interpretation. Responses in this category incorporated the concept of truth as a qualification of knowledge or information (e.g., “knowledge and information are not always true”). Participants in the *subjectivity of truth* category ($n = 32, 10.26\%$) had responses that focused on truth as rare, unknowable, or nonexistent or subjective, personally interpreted, or dependent on context.

Descriptions were coded as *knowledge origin* ($n = 8, 2.56\%$) if they described knowledge as the starting point or basis from which information or truth was obtained (e.g., “If you have knowledge, you can interpret information”). Similarly, the *information origin* category ($n = 106, 33.97\%$) included responses that described information as the starting point or basis for developing knowledge or truth (e.g., “From information one gathers knowledge...and from knowledge comes the development of personal truths”). The *truth origin* category ($n = 18, 5.77\%$) included responses that depicted truth as the basis of knowledge or information. Finally, the *no relation* category ($n = 6; 1.92\%$) included responses that explicitly indicated that knowledge, information, and truth were not related or disconnected.

Conceptions of knowledge, information, and truth across educational contexts Results are displayed in Table 2. Across the USA and the Netherlands, participants’ characterizations of the interrelation of knowledge, information, and truth included themes from one to five of the 10 categories identified. A one-way ANOVA revealed that the descriptions of participants in the Netherlands reflected significantly more conceptual categories ($M = 2.14, SD = 0.97$) than the descriptions of participants in the USA ($M = 1.88, SD = 0.82$), [$F(1) = 4.93, p < 0.05$]. The most popular categorization was the *relative relation* category (39.74%, $n = 124$), which discussed knowledge, information, and truth either in terms of their relative importance or amounts. Participants’ understandings of the target constructs also commonly discussed the *subjectivity of knowledge or information* (35.90%, $n = 112$) and *information as origin* (33.97%, $n = 106$).

A series of chi-square tests of independence were conducted to determine if there were differences in participants’ descriptions across educational contexts. As the two variables included in the analyses each had two levels (i.e., educational context: USA or Netherlands; and category membership: yes or no), the continuity correction was used for each chi-square test. There was a significant difference across educational contexts in students’ conceptualization of the constructs as being subjective or contextually based, $\chi^2(1) = 10.66, p < 0.01$. Specifically, a view of *knowledge or information as subjective* was more commonly endorsed by students in the Netherlands ($n = 38, 52.8\%$), as compared to students in the USA ($n = 74,$

30.8%). Further, there was a significant difference across educational contexts in the frequency of participants describing *truth as subjective*; $\chi^2(1) = 7.34$, $p < 0.01$. Only 7.5% ($n = 18$) of participants in the USA described truth in this way, as compared with 19.4% ($n = 14$) of participants in the Netherlands (Table 6).

Discussion

The current psychological literature is replete with studies of individuals' beliefs about knowledge and knowing and the significance of such beliefs for learning, development, and instruction (e.g., Bråten et al. 2011; Mason et al. 2011; Schommer 1990). It was our goal in this investigation to expand on that rich literature by juxtaposing students' conceptions of knowledge with their potentially relevant beliefs about the nature of information and truth, and to ascertain whether the context in which students were formally educated might play a role in the conceptualizations they offered. Results from the present exploratory study contribute to current understandings about students' beliefs in the digital age and cross-contextual differences in beliefs in a number of ways. First, this study is among the few to explicitly examine students' beliefs about the constructs of knowledge, information, and truth, constructs examined indirectly in much work examining students' information use on the Internet (e.g., Mason et al. 2010; Metzger et al. 2003). Findings from the current study support prior reconceptualizations of student beliefs by underscoring the interrelated nature of beliefs about information and truth in relation to knowledge (Lankshear 2003; Lankshear et al. 1996). Second, this study examined the manifestation of KIT beliefs across two contexts differing in

Table 6 KIT profile by country

Category	The USA	The Netherlands	Total
Truth establishment	23.8% ($n = 57$)	25.0% ($n = 18$)	24.04% ($n = 75$)
Knowledge establishment	20.0% ($n = 48$)	20.8% ($n = 15$)	20.19% ($n = 63$)
Relative relation	39.6% ($n = 95$)	40.3% ($n = 29$)	39.74% ($n = 124$)
Interrelated	18.8% ($n = 45$)	8.3% ($n = 6$)	16.35% ($n = 51$)
Subjectivity of knowledge/information	30.8%** ($n = 74$)	52.8%** ($n = 38$)	35.90% ($n = 112$)
Subjectivity of truth	7.1%** ($n = 17$)	19.4%** ($n = 14$)	10.26% ($n = 32$)
Knowledge origin	2.9% ($n = 7$)	1.4% ($n = 1$)	2.56% ($n = 8$)
Information origin	33.8% ($n = 81$)	34.7% ($n = 25$)	33.97% ($n = 106$)
Truth origin	5.8% ($n = 14$)	5.6% ($n = 4$)	5.77% ($n = 18$)
No relation	2.5% ($n = 6$)	0.0% ($n = 0$)	1.92% ($n = 6$)
Other	2.9% ($n = 7$)	5.6% ($n = 4$)	3.51% ($n = 11$)

**Significance at the $\alpha < 0.01$ level

both culture and curriculum. In this way, results from this exploratory investigation add to previous conceptualizations of beliefs by demonstrating that the development of KIT beliefs may be influenced by students' cultural and learning contexts. Prior calls for the examination of KIT beliefs have emphasized the role of digital context in shaping students' beliefs about information and truth in relation to knowledge (Lankshear 2003; Lankshear et al. 1996). The present study expands the notion of contexts, revealing that cultural and educational contexts may have meaningful contributions to the beliefs that students develop.

Results identifying common trends across educational and cultural contexts will be reviewed first, followed by a discussion of the differences between US and Dutch students in conceptions of KIT beliefs. Implications for future research and educational practice are presented within each section.

Shared conceptions of knowledge, information, and truth

Perhaps most important to our evolving conception of KIT beliefs is the conclusion that, across cultural settings, participants conceptualized the constructs of knowledge, information, and truth, as related to one another, even when afforded with the opportunity to separately represent these notions. This echoes recent trends aimed at reconceptualizing traditional notions of beliefs about knowledge to also consider students' beliefs about information and truth (Lankshear 2003; Lankshear et al. 1996). Students' interrelated conception of these constructs was identified not only when students were asked about these three constructs together, but also when students defined each of these constructs individually. For instance, students in both the USA and the Netherlands commonly defined knowledge as either processed or stored information, conceptions that echo back to constructivist and information processing-related conceptions of knowledge. Similarly, students' definitions of both information and truth included conceptions of these as factual, suggesting a shared understanding of these constructs. Collectively, these results point to the need for further investigation of KIT beliefs. Moreover, both the definition and the interrelation justification categories identified were reliable and consistent with the results in prior work describing KIT beliefs (Alexander et al. 2012; Grossnickle et al. 2015).

Even though the experimental task was designed to allow students to depict knowledge, information, and truth in any configuration, it was rare for students to graphically or verbally position any of the terms as unrelated to the others. For more than one third of the participants in the USA and the Netherlands, that relation was one of evaluating and comparing the relative importance of these terms, highlighting that participants conceptualized these constructs as both somewhat distinct from, yet associated with, each other. Additionally, across contexts, students' descriptions conceptualized information as the foundation or origin of knowledge and truth, highlighting the important role of information in these students' academic lives. Such a view is consistent with theories of knowledge management and information system design (Tuomi 2000; Van der Spek and Spijkervet 1997) and aligns with prior theories suggesting these concepts are interrelated for students' source use in the digital age (Lankshear 2003; Lankshear et al. 1996).

Of particular interest is the manner in which individuals conceptualized the relation between knowledge and information. For example, when defining knowledge, participants frequently described it as stored or processed information, aligning with information processing and problem-solving theories (e.g., Newell and Simon 1972), in which individuals are regarded as active cognitive participants. In contrast, approximately 10% of participants defined these terms synonymously. For educators, this suggests that it might be challenging for students who perceive

knowledge and information as the same to conceptualize themselves as active participants in a process of transforming information into knowledge (Ackoff 1989; Rowley 2007) or applying their knowledge to learning new information (Kettinger and Li 2010; Tuomi 2000). This is of particular importance when considering digital learning, where information may be easily transferred without a perceived need for transformation on the part of the student (Erstad et al. 2007; Purcell et al. 2013). However, there were many indicators that students frequently regarded the relation between knowledge and information as a transformative or procedural process.

Further, results revealed certain trends in undergraduates' beliefs in the importance of justifying or otherwise substantiating knowledge, information, and truth. In defining each of these terms, a substantial portion of participants' definitions reflected a concern with the basis for or truthfulness of each construct. Research in epistemic beliefs has identified the focus on appropriate justification and substantiation as indicative of more sophisticated beliefs and as associated with positive learning outcomes (Greene et al. 2010; Hofer and Pintrich 1997; Mason et al. 2010). The present study suggests that across contexts, individuals may apply similar criteria in thinking about information and truth. For instance, this was evident when students defined truth as *substantiated/proven*, suggesting that it required evidence. These results imply that educators may be able to capitalize on students' beliefs about the need for justification in order to teach specific strategies for critically evaluating information in digital contexts. Understanding truth, as it relates to knowledge and information, has important implications for characterizing how students engage within digital environments, where knowledge and information may be confounded, and where the truth of online information may be difficult to judge (Lankshear 2003; Lankshear et al. 2000). Overall, these findings point to students' conceptions of information and truth as newly emerging and changing in the digital age, in contrast to the more established construct of knowledge. This reinforces the call to consider students' conceptions of knowledge in relation to their conceptions of information and truth (Lankshear 2003; Lankshear et al. 1996).

Cross-context differences

In light of these shared conceptualizations, meaningful differences emerged with respect to participants' educational and cultural backgrounds, with the caveat that due to the exploratory nature of this study, these could not be disentangled. First, significant differences in definitions of information and truth emerged; however, there were no cross-context differences in conceptions of knowledge, the construct more traditionally associated with epistemic beliefs. For information, participants in the Netherlands more commonly defined information as synonymous with knowledge or an aspect of knowledge, whereas participants in the USA more commonly defined information as facts or data. Moreover, participants in the Netherlands were more likely to define truth as a precursor to or criteria for knowledge and information, whereas participants in the USA were more likely to define truth as substantiated or proven. Additionally, in the Netherlands, participants tended to associate truth with knowledge and information to a greater extent than their American counterparts. Although the presence of such differences in students' beliefs across cultural contexts is consistent with previous findings documenting the impact of culture on beliefs (e.g., Karabenick and Moosa 2005), further exploration is needed to understand why the constructs of information and truth seem to be more context-variant, as compared to knowledge.

Similarly, with regard to their beliefs about the interrelation of knowledge, information, and truth, there was evidence that students in the Netherlands were more likely than students in the

USA to have descriptions that fell into the *subjectivity of information or knowledge* category, as well as the *subjectivity of truth* category. That is, the Dutch students were more apt to relate information to an individual's knowledge, to relate truth to knowledge and information, and to recognize the personal or individual variations associated with these constructs. Their more frequent identification of personal or individual variations align with theories emphasizing the contextualized nature of truth (Davidson 1996) and represent a contrast to their American counterparts who tended to accept information on face value as “fact” or “reality.”

Perhaps, such findings can be linked to the PBL approach to which the Dutch students were exposed—an approach that is less common within American undergraduate education. That is, it is possible that the PBL curriculum used at the university in the Netherlands supports a greater emphasis on understanding the relative nature of knowledge and information as students are taught to answer academic problems with sources of their selection: sources that must be evaluated and justified (Loyens et al. 2008). By contrast, US college students may be more exposed to instructional methods where the content is conveyed via lecture or textbooks (i.e., external authorities) that seemingly require less verification or justification on their part. These contextual differences could possibly translate into the greater complexity found in Dutch students' conceptions of the interrelations among knowledge, information, and truth. As they are required to develop personal answers autonomously, these students may have a more nuanced and developed understanding of all of these concepts, overall, as compared to their US counterparts. Nevertheless, while earlier examinations of epistemic beliefs have conceptualized these as falling along a continuum in their sophistication (e.g., Mason et al. 2011; Mason et al. 2010; Schommer 1993, 1998), the exploratory nature of this study means that patterns in students' KIT beliefs are presented only descriptively, with no conclusions drawn about the relative sophistication or adaptiveness of such beliefs.

Limitations

In light of these findings, a number of limitations must be discussed. First, due to the exploratory nature of this study, we were not able to attribute the distinct effects of educational context and culture on students' KIT beliefs. Future studies should compare the epistemic beliefs of students learning in diverse educational settings, but within a similar cultural context (e.g., Muis and Sinatra 2008). Beyond disentangling the dual role of culture and educational context in shaping students' KIT beliefs, it is further necessary to determine the specific factors in both educational (e.g., class size, instructor training) and cultural settings (e.g., language, values) that impact such beliefs, either separately or in combination. Future work—qualitative, correlational, and experimental in nature—is required to systematically examine the specific instructional and cultural components that contribute to the development of students' beliefs about knowledge, information, and truth, and their interrelations, over time.

A second limitation related to the disentangling of culture and educational context has to do with the role of language in the measurement of KIT beliefs. The study was administered in English to both US and Dutch participants, with Dutch participants able to answer in English or Dutch. This methodological decision was undertaken for a number of reasons. First, for Dutch students, the language of instruction was English, rather than Dutch, meaning that administering the study in English aligned well with tapping students' KIT beliefs, as they manifest within educational settings. Second, English presentation aided data analysis by English-speaking members of the research team. At the same time, a number of limitations must be acknowledged as associated with this methodological decision. First, Dutch

participants may not have understood English terms for knowledge, information, and truth in a way similar to their American counterparts. While variation in cross-sample conceptions of these terms was a primary question explored in this study, the extent to which the differences to emerge were only linguistic, rather than cognitive, in nature remains unclear. In particular, while all Dutch students completing the study were deemed sufficiently English proficient to take classes in English, it may be the case that Dutch students conceptualize knowledge and information, when presented with such terms in English, distinctly, as compared to when such terms are introduced in their native language. This limitation is particularly important to consider given the domain-specific and heavily linguistic nature of epistemic beliefs. Finally, some ambiguity in students' conceptions of KIT beliefs may have been introduced through the translation of students' responses from Dutch to English for analysis. However, the inclusion of graphic depictions in addition to verbal justifications provided participants a nonlinguistic format for representing their beliefs and was designed to support students, both English and Dutch, in representing KIT beliefs linguistically.

Conclusion

To provide a critical insight into learners' experiences in the increasing complexity of today's educational environments requires inquiry into students' beliefs about such elusive and abstract constructs as knowledge, information, and truth. As findings from this study suggest, in today's information age, it is becoming increasingly necessary to conceptualize the construct of knowledge in relation to the associated constructs of information and truth. Moreover, students' beliefs may be sensitive to the contexts in which they are educated. For researchers and educators, this provides an opportunity to consider the mechanisms of these differences and the means by which educational contexts can be modified to support the positive development of students' beliefs.

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Current themes of research:

Multiple text comprehension and integration. Multiple text evaluation. Individual differences in multiple source use.

Most relevant publications in the field of Psychology of Education:

List, A., Grossnickle, E. M., & Alexander, P. A. (2016). Profiling students' multiple source use by question type. *Reading Psychology, 37*(5), 753–797.

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Current themes of research:

Relational reasoning. Interest. Curiosity. Text processing.

Most relevant publications in the field of Psychology of Education:

Grossnickle, E. M., List, A., & Alexander, P. A. (2015). Elementary and middle school students' conceptions of knowledge, information, and truth. *The Journal of Experimental Education, 83*(4), 469–494.

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Current themes of research:

Relational reasoning. Expertise development. Reading. Epistemic beliefs.

Most relevant publications in the field of Psychology of Education:

Alexander, P. A., Winters, F. I., Loughlin, S. M., & Grossnickle, E. M. (2012). Students' conceptions of knowledge, information, and truth. *Learning and Instruction, 22*(1), 1–15.

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Current themes of research:

Problem-based learning. Motivation. Video-based modeling.

Most relevant publications in the field of Psychology of Education:

Loyens, S. M., Magda, J., & Rikers, R. M. (2008). Self-directed learning in problem-based learning and its relationships with self-regulated learning. *Educational Psychology Review, 20*(4), 411–427.

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