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Beliefs about Knowledge, Ability, and Cognition in University Physical Education Students

Croyances relatives au savoir, aux aptitudes et à la cognition chez les universitaires qui étudient en éducation physique

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Relations between achievement and beliefs about ability, the need for cognition, and knowledge – specifically beliefs about the simplicity, stability, and speed of knowledge acquisition – were explored in approximately 450 university physical education majors. The need for cognition and beliefs about knowledge (particularly a belief in the simple integration of stable knowledge) predicted achievement in university physical education and differed significantly across the four years of university. Believing that knowledge is uncomplicated, unrelated, absolute, unchanging, and can be quickly learned also related positively to an entity ability conception and negatively to achievement and the need for cognition in this physical education sample. Our results – particularly the finding that students with more sophisticated beliefs about the simplicity and stability of knowledge and the need for cognition performed better – highlight the merit of believing that knowledge in university physical education is not static and simplistic and that cognition is important.

Cette étude, qui porte sur 450 étudiants universitaires se spécialisant en éducation physique, examine les liens entre les réalisations et les croyances touchant l'aptitude, la quête de cognition et le savoir, particulièrement les croyances ayant trait à la simplicité, à la stabilité et à la rapidité de l'acquisition du savoir. La quête de cognition et de croyances entourant le savoir (surtout une croyance en la simple intégration d'un savoir stable) aide à prédire la réussite universitaire dans le domaine de l'éducation physique et varie grandement au fil des quatre années d'études universitaires. Croire que le savoir n'est ni compliqué, ni relié et qu'il est absolu, inchangeable et rapidement absorbé permet d'établir des liens positifs avec la conception des habiletés d'une entité, ainsi que des liens négatifs avec la réalisation et la quête de cognition dans cet échantillon d'étudiants en éducation physique. Les résultats, surtout la constatation d'un rendement supérieur chez les étudiants dont les croyances en matière de simplicité et de stabilité du savoir, et de nécessité d'une cognition,

semblent plus raffinées et confirment l'utilité de croire que le savoir en éducation physique acquis à l'université n'est pas statique et simpliste, et que la cognition est importante.

Introduction

Knowledge is influential in human movement (McPherson & Kernodle, 2003), physical education (Dodds, Griffin & Placek, 2001; Solmon & Lee, 1997), and academic performance (Alexander & Judy, 1988). Knowledge is also influenced by many psychological and contextual factors such as self-beliefs that help learners act as personal agents in their learning by enabling them to feel more in control of their actions and environment (Bandura, 1986). Little is yet known regarding how beliefs about knowledge, ability, and cognition – specifically that cognition is unimportant, that learning occurs quickly or not at all, and that ability is an innate rather than a learned condition − influence achievement in movement-related domains like physical education. This study explores links among and between these beliefs and students' achievement and year in university physical education.

Knowledge and Cognition

Knowledge for the purposes of this study is psychological and contextual by referring to an "individual's personal stock of information, skills, experiences, beliefs and memories; encompassing all that a person knows or believes to be true" (Alexander, Schallert, & Hare, 1991, p. 317) that is also "epistemologically justifiable (philosophical perspective)" (Royce, 1978, p. 148). Domain knowledge encompasses a field of study or realm of thought (Alexander et al., 1991). In academic settings, expert learners generally have more domain-specific knowledge enabling greater comprehension and memory of new material than novices (Alexander & Judy, 1988). Many of these same cognitive processing superiorities are evident in experts in high-strategy sports (McPherson & Kernodle, 2003) and physical education (Ommundsen, 2003; Solmon, 2006). Similar to high academic achievers, individuals with proficient motor and sports skills seem to have more knowledge than novices (Chi, Feltovich & Glaser, 1981) and process information and strategically decide more rapidly (McPherson & Kernodle, 2003).

Need for Cognition

Holding a belief in the need for cognition – one's tendency to employ and take pleasure in attempting to utilize cognition – has also been related to numerous factors of academic performance. A conviction for or against a need for cognition has been statistically linked to being able to manage content ambiguities (Kardash & Scholes, 1996), a willingness and capability for argumentation and problem solving (Nussbaum & Bendixen, 2003), and effort, maintaining attention, satisfaction, and achievement when working on complex learning tasks (Sadowski & Gulgoz, 1992). In other words, individuals reporting a high need for cognition on particularly open-ended tasks that may not have an absolutely correct answer tend to be more aware of how difficult it will be to, for example, adequately consider multiple sources and opinions to resolve the problem. Although these studies have consistently established that students with a higher need for cognition generally tend to be more motivated for and engage more deeply in complex learning tasks, more specific research is needed into

relations between such achievement variables in a physical education setting. For example, the important role of cognitive processing and declarative, procedural, and strategic knowledge in movement-oriented domains like physical education and games is clear (Dodds et al., 2001). If research on the need for cognition in other domains applies similarly to physical education, it would be expected that, for example, students reporting a low need for cognition would under-emphasize the importance of such knowledge, have less of it, and would use and enjoy using their cognition (e.g., apply learning strategies) less when completing problem-solving tasks in physical education – all of which might reflect lower achievement scores (Kardash & Scholes, 1996).

Beliefs about Knowledge

Epistemology is a philosophical inquest into the nature of knowledge and knowing – understanding more about the origin, composition, foundation, and methods for justifying human knowledge (Hofer, 2002). There is a burgeoning field of research studying epistemological development educationally from various theoretical frameworks (for reviews see Hofer & Pintrich, 1997, 2002; Muis, Bendixen, and Haerle, 2006). Generally, students' beliefs about knowledge exist along a continuum from maladaptive to adaptive and progress from a view of knowledge as absolute (having all the answers), transitional (beginning to accept some uncertainties), independence (questioning authority and viewing their own opinions as valid), and contextual (constructs justified opinions and judgments that account for multiple relative evidence) (Baxter Magolda, 2002).

Within educational psychology, personal epistemology research studies "how individuals come to know, the theories they hold about knowing, and the manner in which such epistemological premises influence the cognitive processes of thinking and reasoning" (Hofer & Pintrich, 1997, p. 88). Three dimensions of beliefs about knowledge consistently evident in this research paradigm are the simplicity and stability of knowledge and the speed of knowledge acquisition. Having a conviction that knowledge is simple reflects a belief that knowledge is clear, uncomplicated, and unrelated, while viewing knowledge as stable depicts knowledge as absolute, certain, and unchanging. Students' views about the speed of learning can vary from believing knowledge is something that happens rather quickly to one that asserts that knowledge is acquired more gradually through a self-regulated process. Students who assert that learning occurs quickly do not seem to engage with or persist through the content of a complex task long enough to process it deeply (Lodewyk, 2007; Schommer, 1990, 1993).

In educational research, more sophisticated beliefs about knowledge have been linked to higher academic achievement (Lodewyk, 2007; Schommer, 1993), approaches to learning and study (Rodriguez & Cano, 2006), conceptual change (Pintrich, Marx, & Boyle, 1993), comprehension (Qian & Alvermann, 1995), motivation (Hofer & Pintrich, 1997, 2002), judging reflectively (Bendixen, Dunkle, & Schraw, 1994), solving problems (Schommer, Crouse, & Rhodes, 1992), depth of information processing (Qian & Alvermann, 1995), changing preconceptions (Lodewyk, 2007), and more advanced capabilities for strategic studying (Schommer et al., 1992). Conversely, less mature beliefs about knowledge relates to an increase in feelings of helplessness (Pintrich et al., 1993) and judging simplistically without providing suitable justification (Lodewyk, 2007).

In the few investigations of epistemological beliefs within physical education, Lodewyk (2009) reported that high school students' who hold beliefs in the simple integration of knowledge and in stable and useless (lack of importance) knowledge in physical education earn lower grades in physical education. Cothran and Kulinna (2006) found that middle school physical education students' epistemological beliefs varied in their sophistication from an over-reliance on the teacher as the sole transmitter of knowledge to an awareness that knowledge was contextual and could be attained independently and through other sources (i.e., skillful peers). For example, students holding more "absolutist" beliefs about the source and certainty of knowledge were more skeptical about the worthiness of the teacher's role in using indirect teaching strategies (e.g., peer and inquiry) as illustrated by one student's comment: "I don't think this one [peer] is a good idea because the teacher really wouldn't be doing their job. They are the ones that are supposed to be teaching and not leaving it up to the students to do it." (p. 175)

In conceptually related research, Hare and Graber (2000) noted that students' misconceptions about knowledge relative to those of experts were related to their motor skills, semantics, strategies, and tasks in a physical education lesson or activity. From such studies, it can be conjectured that university students majoring in physical education reporting strong beliefs in, for example, the simplicity and stability of knowledge within the major would be prone to a lower academic average in physical education and in being more resistant to altering one's inaccurate pre-conceptions (e.g., information is physical education does not transfer well between games). To illustrate, Kitchener and King (1981) found that students in classroom settings with unlike implicit beliefs differed in their use of strategies while learning and in their thinking and reasoning, each of which affected learning. This relationship may be explained by the students' failure to adequately account for the evolving nature of physical education knowledge and the complexity of the concepts within the domain and their interconnectedness to other domains and even to one's life.

Additional research is needed into the nature of beliefs about knowledge within specific domains such as physical education (Hofer & Pintrich, 2002). This is because beliefs about knowledge may have features that are similar across domains while others may be specific to certain domains (Buehl, Alexander, & Murphy, 2002). For example, a belief that knowledge is simple (disintegrated) could be consistent across domains while the conviction that knowledge is stable (unchanging) may be more pronounced in certain domains like math and physics than in science or the social sciences (Muis et al., 2006). The domain specificity of beliefs about knowledge likely depend on the measure used to assess such beliefs (Muis et al., 2006), the amount of structure (ill-structured versus well-structured) within a domain (Buehl et al., 2002), and the unique knowledge requirements or epistemological assumptions within each domain (Hofer, 2001).

The development of a valid domain-specific (physical education) quantitative measure – a chief aim of this study – would contribute to the research literature because epistemological beliefs have traditionally been assessed primarily through semi-structured interviews (Baxter Magolda, 2002), domain-general quantitative surveys (Schommer, 1993), and through demonstrations of one's ability in argumentative reasoning and making reflective judgments. For example, Kitchener and King's (1981) reflective judgment model

focuses on thinking rather than on learning as it speculates about the role of epistemological beliefs in solving more open-ended learning tasks. Since calls were made for more domain-specific measures, several new domain-specific and culturally-relevant quantitative measures have been developed (Chan & Elliott, 2004; Lodewyk, 2009; Qian & Alvermann, 1995); but one has yet to be established for validation in a university physical education setting.

Conceptions of Ability

Conceptions of ability are a self-belief about the extent to which learning can be developed through concentrated hard work (incremental ability) or is simply reliant on innate (fixed) ability. The concept originated from Dweck and Leggett's (1988) research reporting that students who believe that intelligence and/or ability can increase incrementally were more likely to attribute achievement to effort, held more adaptive learning-oriented goals, and exhibited more self-determination and persistence in the face of challenges. Conversely, those holding convictions that ability is innate typically attribute failures more to lack of ability than to effort, and sacrifice learning and effort in order to appear smart or avoid looking foolish. This may be because these students believe that, since effort implies low ability, demonstrating effort is counterproductive.

Research on ability conceptions in sport and physical education has reported that students who endorse an incremental-learning physical ability conception tend to use self-regulatory strategies more advantageously (Ommundsen, 2003), show more enjoyment (Biddle, Wang, Chatzisarantis, & Spray, 2003), and believe that effort can mediate ability to enable one to attain his or her potential (Li, Lee, & Solmon, 2005). Meanwhile, those with more of an entity conception of ability demonstrate less effort, intrinsic motivation (Biddle et al., 2003; Li et al., 2005) and self-regulatory strategies while reporting higher anxiety and more self-handicapping behaviors (Ommundsen, 2001, 2003).

Rationale

Research jointly investigating need for cognition, ability conceptions, beliefs about knowledge and achievement – particularly relative to physical education – is scant. The limited evidence suggests that a reduced belief in the need for cognition relates to stronger views in the simplicity and stability (certainty) of academic knowledge (Crowson, 2003). Thus, individuals who have less need for cognition are more prone to believing that academic knowledge in various domains is isolated and unchanging. This has implications on students' potential to actively discuss, construct knowledge, and integrate ideas when learning. Two empirical studies have investigated ability conceptions and beliefs about knowledge. First, studying the respective roles of beliefs about knowledge and ability conceptions in Norwegian postsecondary students, Braten and Stromso (2005) found that beliefs about knowledge more strongly predicted self-regulated learning than implicit theories of intelligence. Second, in a study of high school physical education students, Lodewyk (2009) reported that both entity (positively) and incremental (inversely) ability conceptions significantly predicted belief in the simple integration of knowledge and in the simple utility for knowledge. Both studies revealed that beliefs about knowledge and ability are related yet distinct constructs and welcome additional domain-specific research as to their relationship to each other and to achievement.

Learning more about how these beliefs relative to physical education change over four years of university will help illuminate their potential role in the domain. Beliefs about knowledge tend to mature as students age and progress academically (Baxter-Magolda, 2002; King & Kitchener, 1994). Such age-related developments have yet to be investigated in physical education. Further, although no known studies have empirically demonstrated progression in the need for cognition as a student ages or progresses in school, strong associations between it, academic achievement (Sadowski & Gulgoz, 1992) and related factors like argumentation and elaborative processing (Kardash & Scholes, 1996; Nussbaum & Bendixen, 2003) provide some impetus for such progressions. In assessing ability conceptions in both academic and physical domains with children, Fry and Duda (1997) found that ability conceptions matured with age.

Objectives

The overall purpose of this study is to develop and test a quantitative measure for assessing beliefs about knowledge in physical education; to determine relations among beliefs about knowledge, ability, and need for cognition and how each associate with achievement in physical education; and, to assess developmental differences in these beliefs. We generally anticipate that since undergraduate physical education majors likely recognize the importance of knowledge, purposeful effort, and deeper processing for succeeding academically in university physical education, beliefs about knowledge, ability, and the need for cognition will relate significantly while collectively and separately predicting achievement in physical education.

There are four specific objectives for the study. First, the factor structure and psychometric properties of a new quantitative measure for assessing beliefs about epistemology in university physical education students is assessed. Second, the validity of beliefs about knowledge and the need for cognition are assessed by exposing statistical associations among these beliefs and ability conceptions. On the basis of Lodewyk (2009) and Braten and Stromso's (2005) results, we anticipate that beliefs about knowledge will relate statistically to and make unique conceptual and empirical research contributions beyond the influence of ability conceptions. Third, predictive relations between students' achievement in physical education and their beliefs about knowledge, ability, and the need for cognition are sought. Finally, developmental differences in beliefs about knowledge, ability, and need for cognition are examined across the years of undergraduate study. On the basis of research evidence from other domains (Baxter-Magolda, 2002; King & Kitchener, 1994), we expect beliefs about physical education knowledge to become increasingly sophisticated over the four years of undergraduate study as undergraduates recognize more of the importance of knowledge, purposeful effort, and deeper processing in physical education.

Methods

Participants and Procedure

An overall sample of 469 volunteering undergraduate students majoring in physical education (82% participation rate) at a large public university (n = 14,000) in south central Canada completed three short questionnaires tapping their beliefs about knowledge, ability, and the need for cognition. The surveys were administered by the first author and were completed in approximately 15

minutes during one of their semester-long physical education courses. Before completing the surveys or indicating their consent, students were visually (consent forms) and verbally (first author) informed that the purpose of the study was to collect information about their beliefs about knowledge, ability, and cognition in physical education. They were also reminded that there were no correct or incorrect answers and ensured of the confidentially and anonymity of their responses. Following an analysis of multivariate outliers using Mahalanobis Distance ($p < .001$) as the criterion, 15 students were deleted from the sample culminating in a final sample of 454 (285 females, 169 males) across all four years of undergraduate study (first year = 84; second year = 74; third year = 192; fourth or more years = 104). Most were in a middle-class socioeconomic status and were Caucasian (95.8%).

Measures

Beliefs about knowledge. To assess students' beliefs about knowledge, a questionnaire developed by the authors entitled *Beliefs about Knowledge in Physical Education Questionnaire* (BEPEQ) was administered. Items were selected through a 5-step process. First, items ($N = 22$) with high factor loadings (> .45) for either the simplicity ($n = 13$), stability ($n = 6$), or speed of knowledge acquisition ($n = 3$) were selected by the lead Lodewyk from valid measures used previously in educational research measuring beliefs about knowledge (e.g., Buehl et al., 2002; Hofer, 2002; Schommer, 1993; Schommer et al., 2002). Second, the pool of items was screened for conceptual relevance to their proposed factors by two established epistemological belief researchers. Third, three physical education experts were asked to assess the content relevance of each of the proposed items to physical education. Finally, a pilot study was conducted with 25 second and third-year physical education majors from the same university. These students were asked to circle ambiguous, misspelled, unclear, or irrelevant items, phrases, or words as they completed the questionnaires. This process failed to reveal concerns with any of the selected items. Prior to statistical analyses, missing data were replaced by the mean of nearby values. One item from the BEPEQ deviated from normality (Tabachnick & Fidell, 2006) and was deleted which resulted in a 21-item measure.

Items were randomly distributed to decrease repetition and negatively weighted items were counterbalanced to promote authentic completion of the questionnaire. A 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5) was used. Higher values for each factor reflected a stronger belief for what that factor represented. For example, students scoring high in simplicity of knowledge would believe more strongly that knowledge in university physical education is clear, uncomplicated, and not highly integrated to other concepts inside or outside the domain. Examples of items representing each dimension are: "A challenge in physical education can be approached in several different ways" (simplicity of knowledge) (Buehl et al., 2002); "The concepts to be learned in physical education are unchanging" (stability of knowledge) (Hofer, 2002); and, "In physical education, if I cannot understand something quickly, it usually means I will never understand it" (speed of knowledge acquisition) (Schommer, 1993).

Ability conceptions. Beliefs about ability in physical education were assessed using the *Conceptions of the Nature of Sport Ability II Questionnaire* (CNAAQII). This 12-item measure uses a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). It has been validated in previous research in physical education (Ommundsen, 2003) and sports (Biddle et al., 2003) with two first-order factors: Incremental (six items) and entity (six items) ability conceptions. Students who conceive of ability as incremental (IAC) believe that it is a product of learning and improving through effort. Those holding a belief that ability is an entity (EAC) espouse that ability in physical education is inherited (innate gift) and, that even with effort, cannot be changed. In previous research (Ommundsen, 2003), the CNAAQII has demonstrated a consistent factor structure with satisfactory goodness of fit indices (χ^2 (51) = 89.78; CFI = .95), internal consistency coefficients for factors (.74 - .84), and evidence of predictive validity through established relations with achievement-related variables. For example, Biddle et al. (2003) found that, in children aged 11-14, incremental beliefs tend to be characteristic of individuals that enjoy sports more and have a task goal-orientation while entity beliefs seem to facilitate ego goal-orientations and a lack of motivation particularly in individuals with low perceived competence. Item examples are: "To be good at physical education, you need to be born with the basic qualities which allow you success" (entity) and "How good you are at physical education will always improve if you work at it" (incremental).

Need for cognition. Beliefs about the necessity for cognition in physical education were tapped using 8 of the 18 items on the *Need for Cognition Questionnaire* (NCQ) used previously in educational research with university students (Kardash & Scholes, 1996). The eight selected items were chosen by the first Lodewyk because the others in the NCQ were not deemed to be sufficiently relevant for gauging students' beliefs about the need for cognition within physical education. In other words, the deleted items assessed a more general belief in the need for cognition (e.g., "I prefer my life to be filled with puzzles that I must solve"). Sample items include: "I really enjoy tasks in physical education that involve coming up with new solutions to problems" and "I prefer tasks in physical education that make me think than those that do not." The NCQ uses a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). A larger score indicates a higher need for cognition or more specifically, a desire for getting involved in challenging situations that require more intense thought, problem-solving, and critical-thinking in physical education.

Each item was screened using a validation process similar to that described earlier for the development of the BEPEQ. Results of analysis from two physical education experts and the same pilot study revealed no problem items. We further justify our use of the modified measure by citing the sound construct validation and internal consistency reliabilities (coefficient alpha in the range of .90) in other uses of the NCQ (e.g., Kardash & Scholes, 1996). To ensure adequate reliability of the scale, we will include the scale only if the internal consistency reliability coefficient is above the recommended level of .60 for scales with fewer than 10 items (Loewenthal, 1996).

Achievement. On a short *Demographic Survey*, students answered several questions about their year in university, age, ethnicity, socio-economic status, and the average percentage grade they generally attained in the university physical education courses (Mean = 77.56%; SD = 5.88). Correspondence of letter to percentage grades was: >79.55 = A; 79.54 - 69.55 = B; 69.54 – 59.55 = C; 59.54 – 49.55 = D; < 49.54 = F. Their grade was based on 30 half-credit (semester) courses within the Physical Education and Kinesiology Department that followed a fixed schedule of courses according to students' year in university. Among these were required courses in Anatomy (2), Physiology (2), Foundations of Movement Studies, Developmental Games, Educational Gymnastics, Dance Education, Growth and Motor Development, Motor Behavior, Research Design and Evaluation, Health and Physical Activity, Exercise Physiology, History of Physical Education and Sport, Adapted Physical Education, Sport Psychology, Data Analysis, Biomechanics, Movement Philosophy, Lifespan Physical Activity, and several movement-oriented elective courses (e.g., Formal Games, Advanced Dance and/or Educational Gymnastics, Outdoor Education). This physical education major is accredited by the Canadian University Physical Education and Kinesiology Administrators (CUPEKA). Screening of the major by a lead reviewer for the National (United States) Council for the Accreditation of Teacher Educators (NCATE) and the National (United States) Association for Sport and Physical Education (NASPE) reported that the content knowledge required in this major is consistent with that recommended by NCATE-NASPE and with the International Council for Sport, Health, Physical Education, Recreation, and Dance (2009). Consequently, physical education achievement in this study appears to reflect that of many other undergraduate physical education programs.

Students in this study were generally aware of their achievement average within their university major since it was computed and accessible to them on-line along with their non-major average and overall academic average in their university academic record. This average was used by the department and university to ensure students earned the minimum standards to remain in the major (> 65%), graduate, or apply for graduate school or Bachelor of Education degree programs. As further validation of this achievement measure, we highlight the previous use of self-reported achievement in published educational research (e.g., Lodewyk, 2009; Lodewyk & Winne, 2005) that has been highly accurate in undergraduate students. For example, Winne and Jamieson-Noel (2002) revealed a correlation of .88 and a reliability index of .82 for calibration of achievement in university students. Nevertheless, we note as a caution the inherent variability in students' interpretations and reports of their achievement within any major. We also recognize that students' conceptualization of this major or the domain of physical education in this study may differ from those in other settings and naturally restricts the transferability of our results to dissimilar undergraduate contexts.

Results

Factor Structure

To meet our first objective – assessing the factor structure and psychometric properties of a new quantitative measure for assessing beliefs about epistemology in university physical education students – the sample was randomly split into

two sub-samples (n = 200 and 254). The first of these (n = 200) was used for an exploratory factor analysis (EFA) to uncover any model inherent in the data. Any emergent model would then be confirmed through a CFA with the second independent sample. The EFA used the maximum likelihood method of extraction and a direct oblimin rotation. These procedures used SPSS 15.1.0.1. In order to remain consistent with the literature (Muis et al., 2006) and attempt to uncover three interrelated factors, factor extraction was forced onto three factors which is a procedure that has been used previously in the discipline (e.g., Braten & Stromso, 2005; Lodewyk, 2009) and has been supported in similar circumstances (e.g., Ferguson & Cox, 1993; Henson & Roberts, 2006). Factor loadings of .43 were interpreted as significant (Tabachnick & Fidell, 2006), and no cross loadings of items on the three factors was allowed.

Table 1
EPEQ Factor Items, Cronbach's Alpha (α), and Exploratory Factor Analysis Loadings (N = 200)

Items and Factors *(α)*	SISK (.66)	QLSK (.67)	JK
1. There are connections between the material in physical education and in other courses.	.63		
2. It is important for students to connect the new ideas learned in physical education to what they already know.	.60		
3. A challenge in physical education can be approached in several different ways.	.58		
4. Answers to questions in physical education change as experts gather more information.	.56		
5. Physical education relates to day to day life.	.53		
6. In physical education, most challenges have only one right answer.		-.78	
7. In physical education, if I cannot understand something quickly, it usually means I will never understand it.		-.52	
8. All experts in physical education understand physical education in the same way.		-.47	
9. To learn information the best in physical education I should memorize the facts.		-.45	
10. If I am ever going to understand something in physical education, it will make sense the first time I hear it.		-.44	
11. Correct answers in physical education are more a matter of opinion than fact.			.62
12. There is really no way to determine whether someone has the right answer in physical education.			.48
Total Variance Explained (23.86%)	15.22	4.03	4.61

Note. Based on a three-factor oblimin rotation; QLSK = Quick Learning of Stable Knowledge; SISK = Simple Integration of Stable Knowledge (items for this factor were all reversed scored); JK = Justification of Knowledge; The following items were adapted (for physical education) and used from the following sources: 1,2,3,5 (Buehl et al., 2002); 7,10 (Schommer et al., 2002); 9 (Schommer, 1993); 4,6,8,11,12 (Hofer, 2002); Items 1-5, 11, 12 are reverse coded.

The EFA revealed that the first factor consisted of five items, accounted for 15.22% of the overall variance, had an eigenvalue of 3.20, and conceptually reflected students' beliefs in Simple Integration of Stable Knowledge (SISK). Students with high levels of SISK report seeing little value in integrating physical education knowledge with knowledge that has been learned previously, is in other (non-physical education) domains, and/or rather practical knowledge that can considered useful for everyday life. They also believe knowledge in physical education is not malleable. In other words, students with such a belief tend to believe that knowledge in university physical education is relatively unchanging, isolated from content from other domains, has little applicability or use for everyday life, and has very little association to what they already know. The second factor loaded five items, accounted for 5.03% of the variance, had an eigenvalue of 1.06, and was named Quick Learning of Stable Knowledge (QLSK). This factor represents a belief that knowledge in physical education consists more of a collection of unchanging facts that are typically interpreted similarly by everyone and can learned quickly. In other words, students high in QLSK tend to believe that knowledge in physical education does not evolve much over time, is either quickly understood or it likely will not be, and has little ambiguity (e.g., debatable concepts). The final factor loaded only two items, represented 4.61 of the variance, had an eigenvalue of .97, and reflected students' belief that they could justify (construct) knowledge rather than simply accept it as fact. Since this factor contained insufficient items for credibility (Tabachnick & Fidell, 2006), it was not used in subsequent analysis. Item and their factors loadings are provided in Table 1.

The fit of this model to the second sample (n = 254) was examined through a confirmatory factor analysis with EQS 6.1. Maximum Likelihood was the method of extraction, and contingent with the oblique rotation in the EFA, a path was allowed between the factors. Values for an excellent fit are fewer than .95 on the CFI (Hu & Bentler, 1999), .05 or less for the RMSEA (Browne & Cudeck, 1993), and .08 or less for the SRMR (Hu & Bentler, 1999). Results of this model included the CFI = .89, RMSEA = .05, and SRMR = .07. Although the CFI value is lower than the criteria for excellent fit to the data, both the RMSEA and SRMR values exceeded the criteria for excellent fit. Several published studies using CFA in physical education and sport do provide similar values for the CFI (e.g., Keating, Guan, Ferguson, Chen & Bridges, 2008; Short, Feltz & Sullivan, 2005). On this basis, we inferred that the model adequately fit the data.

The internal consistency coefficients for the other scales in this study (.66 SISK, and .67 QLSK, .72 for EAC; .60 for IAC, .75 for Need for Cognition,) were deemed suitable to warrant their inclusion in subsequent analyses. Although the conventional value for acceptable internal consistency is .70, Loewenthal (1996) has suggested that with factors comprising less than 10 items, alphas of greater than .60 are acceptable. Moderate correlations (< .45) pre-empted concerns over scale multicollinearity (Tabachnick & Fiddell, 2006). Descriptive statistics and internal consistency coefficients for each belief scale are illustrated in Tables 2 and 3.

Table 2
Descriptive Statistics, Cronbach's Alpha (α), and Pearson Correlations (N = 454)

Factor	α	*M*	*SD*	1	2	3	4	5	6
1. Simple Integration of Stable Knowledge (SISK)	.66	1.76	.39	—					
2. Quick Learning of Stable Knowledge (QLSK)	.67	2.03	.48	.44**	—				
3. Need for Cognition (NC)	.75	3.50	.51	-.43**	-.40**	—			
4. Incremental Ability Conception (IAC)	.60	3.91	.45	-.25**	-.001	.07	—		
5. Entity Ability Conception (EAC)	.72	2.20	.52	.23**	.41**	-.26*	-.07	—	
6. Achievement in physical education (PEA)	—	77.56	5.88	-.27**	-.22**	.25**	-.02	-.08	—

Note. *y*-axis is the outcome variable. * = $p < .05$; ** = $p < .01$,

Belief and Achievement Relations

In line with our second objective, correlations between each of the belief variables were assessed. As depicted in Table 2, with the exception of IAC – which had negligible relations with each belief variable except for SISK – there were significant correlations ($p < .01$) between each of the belief variables. The direction of the relationships met theoretical expectations. For example, the more students believed in SISK and QLSK the higher their EAC (.23, .41) and the lower their beliefs Need for Cognition (NC) (.-43, -.40). Higher SISK was also associated with lower IAC (-.25). Further, NC also had a statistically inverse relationship with EAC (-.26). Thus, a high belief in SISK and/or QLSK related to higher beliefs in EAC and lower beliefs in IAC and NC. Students with a belief in NC were prone to lower beliefs in EAC.

To discover the relative predictive strength of each independent variable a multiple regression ($p < .05$) was performed with each of the independent variables (IAC, EAC, NC, QLSK, SISK) entered simultaneously. Results revealed that the independent variables collectively predicted PEA [$R^2 = .10$, $F(5, 448) = 9.75$, $p < .001$] however, when accounting for the shared variance of each other, only SISK ($\beta = .-.19$, $p < .001$) and NC ($\beta = .13$, $p = .02$) significantly predicted PEA. QLSK ($\beta = -.09$, $p = .08$), IAC ($\beta = -.07$, $p = .11$), and EAC ($\beta = .03$, $p = .53$) did not. Thus, collectively ability conceptions (IAC, EAC), beliefs about knowledge (QLSK, SISK), and need for cognition (NC) predicted achievement in physical education (PEA) yet individually, only beliefs about the simple integration of stable knowledge (SISK) and the need for cognition (NC) did.

Developmental Differences

The final objective of this study was to determine developmental differences in beliefs about knowledge, ability and the need for cognition. Differences (see Table 3) were examined across the four years of undergraduate study using a multivariate analysis of variance (MANOVA). Examination of Levene's test for equality of error variances revealed that the data upheld this assumption for the MANOVA. A main effect for year-of-study was evident [$F(15, 1231.6) = 5.80$, $p < .001$, $\eta^2 = .06$]. Post-hoc one-way ANOVA tests ($p < .05$) indicated that, with the exception of EAC [$F(3, 450) = 1.47$, $p = .22$, $\eta^2 = .01$], there were statistical decreases in SISK [$F(3, 450) = 10.24$, $p < .001$, $\eta^2 = .06$], QLSK [$F(3, 450) = 5.55$, $p = .001$, $\eta^2 = .04$] and IAC [$F(3, 450) = 8.38$, $p < .001$, $\eta^2 = .05$] and increases in NC [$F(3, 450) = 8.01$, $p < .001$, $\eta^2 = .05$]. Thus, during students' four years of undergraduate study, SISK, QLSK, and NC matured, IAC decreased, and EAC did not change.

Table 3
Means and Standard Deviations ( ) for Beliefs by Year in Undergraduate Study

Factor	Year 1	Year 2	Year 3	Year 4
1. Simple Integration of Stable Knowledge	1.93 (.43)	1.72 (.33)	1.78 (.39)	1.62 (.36)
2. Quick Learning of Stable Knowledge	2.19 (.51)	2.07 (.47)	2.00 (.49)	1.92 (.42)
3. Need for Cognition	3.30 (.48)	3.47(.52)	3.51 (.49)	3.65 (.49)
4. Incremental Ability Conception	4.06 (.44)	4.04 (.41)	3.81 (.42)	3.89 (.50)
5. Entity Ability Conception	2.17 (.54)	2.15 (.49)	2.26 (.52)	2.16 (.51)

In summary, results of our first objective revealed the emergence of two conceptually clear factors with satisfactory fit indices and internal consistency coefficients. Second, students with high values in SISK and QLSK were prone to having higher EAC and lower IAC and NC. Further, students with a higher NC tended to believe less in EAC. Third, SISK and NC predicted achievement. Finally, there were changes across the four years of undergraduate study in each belief with the exception of EAC. NC, SISK, and QLSK matured whereas, contrary to expectation, IAC decreased.

Discussion

To recapitulate, this study had four objectives. First, the factor structure and psychometric properties of a new quantitative measure for assessing beliefs about epistemology in university physical education students was assessed. Second, the validity of beliefs about knowledge and the need for cognition were assessed by exposing statistical associations among these beliefs and ability conceptions. Third, predictive relations between students' achievement in physical education and their beliefs about knowledge, ability, and the need for cognition were determined. Finally, developmental differences in beliefs about knowledge, ability, and need for cognition were examined across the years of undergraduate study.

Two conceptually clear factors with satisfactory fit indices and internal consistency coefficients emerged from this study. These were the Simple Integration of Stable Knowledge (SISK) and the Quick Learning of Stable Knowledge (QLSK). This finding and those in other domains (Muis et al., 2006) appear to indicate that the unique features (e.g., structure, knowledge, curriculum, pedagogy, and context) of undergraduate physical education might have contributed to the emergence of QLSK and SISK in this study. These results add support for the role of beliefs about knowledge (SISK, QLSK) as an adequately valid construct for which to account in university physical education. This was reflected in: (1) exploratory and confirmatory factor analysis, (2) satisfactory internal consistencies, (3) statistical and conceptual relations with need for cognition and ability conceptions, and (4) the statistical (though moderate at best) predictive strength of achievement in physical education.

The finding that students with more sophisticated beliefs about the simplicity and stability of knowledge performed better prompt the assertion that students with less mature beliefs about knowledge may over-emphasize the necessary factual information, right and wrong answers, and memorization for succeeding academically in physical education and other domains. Our findings corroborate other research in various educational domains (e.g., Lodewyk, 2007; Schommer, 1990) including physical education (e.g., Cothran & Kulinna, 2006; Lodewyk, 2009) reporting links between holding simplistic beliefs about knowledge and achievement. Physical education students espousing beliefs that knowledge is stable and simply integrated could be biased towards learning facts, seeking a correct answer, or only approaching challenges one way rather than comprehending the ambiguities and respecting the relativity of the content. Consequently, those students may inadequately integrate concepts with prior knowledge and across disciplines or domains or fail to persevere when faced with learning difficulties. This is partially substantiated by Cothran and Kulinna's (2006) study with adolescents in physical education that linked students who

failed to be inquisitive (questioning) or to construct their own knowledge with beliefs that the teacher was the sole source of knowledge and was primarily responsible for their learning. Further, students holding beliefs that knowledge is simple and stable or unchanging might be less prone to perseverance and mastery learning and more susceptible to oversimplifications and reliance on peer-comparisons for setting personal success standards (Muis et al., 2006). Future research that specifically targets differences in beliefs about knowledge between physical education and other domains would be useful.

The need for cognition in this study predicted achievement after accounting for the influence of incremental and entity ability conceptions. This adds to other research noting the importance of knowledge (Dodds, Griffin, & Placek, 2001) and cognitive processing (Solmon, 2006) in physical education. The need for cognition in our study also related negatively to entity ability conceptions and both of the knowledge belief constructs. Crowson (2003) reported similar relations between the need for cognition and beliefs in the simplicity and stability of knowledge in research among university students representing several majors. Our research signals that students with a keen desire to become cognitively involved, while holding beliefs that knowledge is complex, alterable, relative, and ambiguous, tend to perform better in undergraduate physical education. Holding less mature beliefs about knowledge may be especially destructive on tasks that have less structure which students generally perceive as more difficult and that place more demands on reflective judgment capabilities (Bendixen, Dunkle, & Schraw, 1994; Lodewyk, 2007).

In reference to ability conceptions, the potentially harmful influence of entity beliefs was more noteworthy in this study than were the useful effects of incremental conceptions. Students endorsing an incremental view of ability had lower beliefs in the simple integration of SISK while those espousing an entity conception of ability had less sophisticated beliefs about knowledge and a lower need for cognition. This combination of beliefs might predispose students to performance failure by prompting them to underemphasize the role of cognition and to approach knowledge with inadequate awareness of its complexity and relativity and the importance of integration, reasoned argumentation, perseverance, adaptability, and self-regulation. We concur with Ommundsen's (2003) assertion that conceiving of ability as an entity may reduce physical education students' perceived control, increase their anxiety, prompt them to use self-handicapping strategies to avoid the appearance of failure, and subsequently undermine their competence and satisfaction in physical education.

In relation to our fourth query, the need for cognition, and beliefs about knowledge matured across the four years of undergraduate study. This complements other reports that beliefs about personal epistemology (Muis et al., 2006), ability (Li et al., 2005) and need for cognition (Cacioppo, Petty, Feinstein & Jarvis, 1996) develop with age. For example, Schommer (1993) reported that high school students' beliefs in the simplicity and certainty of knowledge and speed of learning improved over the course of their education. Of course, as Hofer (2000) cautions, some items may not be interpretable to early undergraduates. The finding that incremental beliefs decreased over time may reflect students increasing awareness that ability is not as malleable as they believed it was when they entered university. This research is useful for both physical education students and professors in university settings. Being more

aware of what are more or less availing beliefs about knowledge, ability, and the need for cognition, how they are linked to achievement and a host of learning factors, and of its related factors, and how they tend to mature across the years in post-secondary education can help students and professors foster their development. For example, in the content they teach and the problems that they design and assign, professors might consider clearly showing students how complex, ambiguous, multi-dimensional, and evolving knowledge is and how useful cognitive processing procedures (e.g., use of learning strategies) can be on improved problem-resolution and overall achievement. A longitudinal investigation of developmental changes in beliefs about knowledge, ability and cognition in physical education students is welcomed.

In conclusion, post-secondary education is a critical period for considering multiple alternatives to problems, practicing reflective judgments, recognizing associations within and across domains, and gaining awareness that ability is alterable through effort and self-regulation. This study provides evidence for including beliefs about knowledge and the need for cognition to existing constructs like motivational profiles, ability conceptions, and goal orientations as achievement-related factors that need to be considered within physical education. Physical education students who view cognition as unimportant or knowledge as simple, factual, and unchanging may be prone to underestimating the complexity of the domain and of the learning tasks within it which might curtail effective engagement and self-regulated learning by restricting necessary cognitive processing and compromising achievement.

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