Volume 9, No. 3
August 2011
ISSN: 1545-679X

INFORMATION SYSTEMS EDUCATION JOURNAL

In this issue:

EDSIG
Serving Information Systems Educators

The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **EDSIG**, the Education Special Interest Group of AITP, the Association of Information Technology Professionals (Chicago, Illinois). Publishing frequency is quarterly. The first year of publication is 2003.

ISEDJ is published online (http://isedjorg) in connection with ISECON, the Information Systems Education Conference, which is also double-blind peer reviewed. Our sister publication, the Proceedings of ISECON (http://isecon.org) features all papers, panels, workshops, and presentations from the conference.

The journal acceptance review process involves a minimum of three double-blind peer reviews, where both the reviewer is not aware of the identities of the authors and the authors are not aware of the identities of the reviewers. The initial reviews happen before the conference. At that point papers are divided into award papers (top 15%), other journal papers (top 30%), unsettled papers, and non-journal papers. The unsettled papers are subjected to a second round of blind peer review to establish whether they will be accepted to the journal or not. Those papers that are deemed of sufficient quality are accepted for publication in the ISEDJ journal. Currently the target acceptance rate for the journal is about 45%.

Information Systems Education Journal is pleased to be listed in the 1st Edition of Cabell's Directory of Publishing Opportunities in Educational Technology and Library Science, in both the electronic and printed editions. Questions should be addressed to the editor at editor@isedj.org or the publisher at publisher@isedj.org.

INFORMATION SYSTEMS EDUCATION JOURNAL

Editors

ISEDJ Editorial Board

Using Undergraduate Information Systems Student Epistemic Belief Data in Course Design: A Research-based Approach to Improve Student Academic Success

Samuel S. Conn
samuel.conn@kysu.edu

John English
john.english@kysu.edu

Fred Scheffler
fred.scheffler@kysu.edu

Kentucky State University
Frankfort, KY 40601 USA

Simin Hall
simin.hall@vt.edu
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061 USA

Abstract

In this report the authors detail a baseline study involving use of epistemic belief data to enhance academic success collected from an undergraduate student population enrolled in an Information Systems undergraduate degree program. Based on an existing line of inquiry, student epistemic belief data were collected and analyzed to determine student perception of knowledge and levels of self-regulation and self-efficacy. Indicators were determined through item analysis and evaluated for use with an existing epistemic belief profile rubric. Working in concert with course developers, strategies for altering approaches in instructional design, pedagogy, and assessment based on student epistemic beliefs were determined. Researchers from institutions of similar composition can benefit from findings of this study. Moreover, strategies for altering a student population's trajectory toward improved academic success were an outcome of this study and included application and analysis of: (a) student epistemic belief data and its role in higher education, (b) relationships between epistemic beliefs and student academic success, and (c) a methodology for improving student academic success via research-based instructional design, pedagogy, and assessment.

Keywords: Epistemic, beliefs, academic, success, course design, strategy

1. PROBLEM STATEMENT

The problem examined in this study involved use of epistemic beliefs in course design. Student epistemic beliefs, juxtaposed against the theory of knowledge, degrees of student self-regulation, and cognitive development theories, can be used to design more efficacious courses if an integrative methodology is applied. Creation of a course development methodology involving use of student epistemic beliefs is problematic. Relating theory of knowledge, degrees of self-regulation and self-efficacy, and cognitive development theory as dimensions to construct a student population profile and use of student epistemic belief data to position a given student population within the construct is complex.

In this investigation, the authors illustrated the congruence of theory of knowledge, degrees of student self-regulation, and a cognitive development theory as a framework for determining appropriate course instructional design strategies. A rubric involving student epistemic belief profiles was applied in response to a prescriptive-diagnostic approach (Schunk, 1983). Through this research and case-based study the authors wanted to know: a) what are students' epistemic beliefs regarding knowledge; b) what are students' epistemic beliefs regarding self-efficacy; c) what are students' epistemic beliefs regarding self-regulation; and d) what are students' epistemic beliefs regarding instruction? Once determined, the researchers constructed a profile for the student population based on epistemic belief data.

The profile was used to establish a baseline for pedagogy and assessment strategies; using an existing rubric, a strategy for trajectory to higher levels of epistemic belief was plotted. The authors posit that course designers and developers can apply the design elements to achieve a course of instruction in harmony with an existing student population's epistemic beliefs, or to construct a pathway to alter epistemic beliefs toward an optimal goal of constructivism, commitment and constructed knowledge, and high levels of self-regulation

2. LITERATURE REVIEW

Philosophy addresses the nature and rationale for human knowledge through an area of concern referred to as epistemology. According to Hofer and Pintrich (1997), individual epistemology, or epistemic beliefs, involves one's beliefs regarding the nature of knowledge and knowing. Early theorists (e.g., Perry, 1970; Pintrich and Schunk, 2002; Schoenfeld, 1985; and Hofer and Pintrich, 2002) promoted the idea that epistemic beliefs alter students' learning strategies, problem solving capabilities, comprehension, and achievement of learning outcomes. Major theories developed by educational psychologists such as Buehl, Alexander, and Murphy (2002), Hofer and Pintrich (1997), Muis, Bendixen, and Haerle (2006), Piaget (1950), and Schommer (1990) incorporate and apply some element of student epistemic beliefs.

As a result, epistemic beliefs are deemed to influence learning, motivation, and cognition. Integrative studies of student epistemic beliefs with other learning theories and models have evolved over the past few decades, e.g., Bloom, Engelhart, Furst, Hill, & Krathwohl (1956); Ryan(1984a, 1984b); and Muis (2007).

Based on Hofer and Pintrich (1997), epistemic beliefs affect four dimensions of knowledge: (a) certainty of knowledge, (b) simplicity of knowledge, (c) justification for knowing, and (d) source of knowledge. According to Schommer (1990), certainty of knowledge is reflected as a continuum with a belief that knowledge is absolute and unchangeable on one end as opposed to a belief that knowledge is tentative and evolving on the other end. Moreover, simplicity of knowledge is illustrated as a continuum with a belief on one end that knowledge is defined as isolated, unambiguous chunks as opposed to a belief that knowledge is defined as highly interrelated conceptualizations.

According to King and Kitchener (1994), justification for knowledge also can be depicted as a range where knowledge requires no justification to where knowledge is constructed and critically refined and reevaluated. Based on Kuhn (1993), epistemic beliefs influenced by "source of knowledge" can range from total reliance on and acceptance of authoritative experts, to critical evaluation of expert knowledge.

In accordance with Muis (2007), two high-level architectures exist with respect to epistemic beliefs, one motivated by a developmental perspective and one motivated by a multidimensional perspective. Perry's (1970) work illustrates a developmental perspective in defining a student's initial view of knowledge

(absolutism/objectivism), a progression to a more advanced view of knowledge (multiplism/subjectivism), and progressively the highest view of knowledge (evaluativism/objectivism-subjectivism). In contrast, Hammer and Elby (2002), Hofer and Pintrich (1997), and Schommer (1990) proposed multidimensional frameworks, where incremental, non-sequential knowledge dimensions assemble to form and represent knowledge.

Muis (2007) established a relationship between epistemic beliefs, self-efficacy, and self-regulated learning. Investigations, e.g., Ryan (1984b); Schoenfeld (1983, 1985); Schommer (1990); and Hofer (2000), have determined a relationship between epistemic beliefs and levels of meta-cognition. According to Knight and Mattick (2006), researchers increasingly are finding a relationship between epistemic beliefs and disciplinary domains, i.e., epistemological beliefs are discipline specific. In effect, student epistemic beliefs can be juxtaposed with known theories and models of learning to establish baselines for given populations defined by discipline or content domain.

Pintrich and Schunk (2002) demonstrated that successful self-regulated learners possess higher levels of motivation (personal influences), apply more effective learning strategies (behavioral influences) and respond more appropriately to situational demands (environmental influences). In addition, Hofer and Pintrich (1997) hypothesized that epistemic beliefs affect achievement mediated through self-regulated learning.

Schunk (1995) defined self-regulated learning as "learning that results from students' self-generated thoughts and behaviors that are systematically oriented toward the attainment of their learning goals" (p. 125). Moreover, Bandura (1986) showed that self-efficacy beliefs impact performance because these beliefs represent people's perception of their capabilities to perform a task at designated levels. These researchers have provided empirical data on causal or correlation relationships between self-efficacy and epistemic beliefs and self-regulated behaviors and performance in subjects such as mathematics (Pajares & Miller, 1994; Schommer et al, 1992; and Schunk, 1981, 1984).

Social constructivism (Pajares, 2002) provided a basis for this case study's course construction recommendations and related instructional strategies. Social constructivism suggests that the exchange of critical feedback among peers as well as from the instructor can encourage students to modify their work. Learners engaged in a collaborative problem solving process receive feedback and comments from peers and from the teacher on related steps of planning, implementing, and executing problem solving processes rather than only receiving feedback from the instructor on their performance.

Feedback is an important consideration because it requires transfer of knowledge and therefore represents students' gain in problem solving (Clark & Mayer, 2003). In particular, feedback from peers may push students to perform higher level cognitive functions (Schoenfeld, 1983). Furthermore, social cognitive theory posits reciprocal interactions between behaviors, cognitions, and environmental variables (Bandura, 1984) can enhance self-efficacy as it relates to problem solving skills. Feedback from peers and instructor are environmental variables as well as the modes of course delivery that can influence student confidence as it relates to the acquisition of problem solving skills (Schunk & Pajares, 2002).

Moreover, social cognitive theories posit as possible the design of an educational experience such that learning occurs and is enhanced as a result (Marra & Palmer, 2004). Designing a course such that student learning takes place requires examining student epistemic beliefs, how feedback is utilized during learning, as well as student perceptions of teaching and learning. For example, students who require and expect more instruction do so in part because of their epistemic beliefs regarding the nature of knowledge and knowing. Research has shown that epistemic beliefs affect how students approach learning tasks (Schoenfeld, 1983), monitor comprehension (Schommer et al., 1992), and plan for solving problems and carry out those plans (Schommer, 1990).

Course design can be used to enhance collaboration and feedback through active engagement with materials and collaboration with peers and instructors. Online resources such as chat, discussion forum, blog, and wiki can play an active role in facilitating collaboration and feedback. One appeal of asynchronous technologies is that learners can

access materials, complete assignments, participate in discussions, and take exams according to schedules that they themselves determine. Hypermedia learning environments offer particular advantages to learners who are inherently self-directed learners (Mayer, 2002).

However, at many institutions the current population taking courses consists of traditional undergraduates. These students typically require and expect more structure and instruction (Ravert & Evans, 2007). Many students, particularly those with low motivation, achievement, and self-regulation are unwilling to do mindful work, such as executing higher level cognitive processes that are involved in scholastic work (Report to Congress, 2004).

3. METHODOLOGY

Researchers in this study utilized a mixed-method approach in collection of qualitative and quantitative data (Creswell & Clark, 2007). A case study methodology was used to collect relevant qualitative data regarding the subjects of the study, undergraduate students in their first year of study. Likert scale data were collected; survey instrumentation was used to collect quantitative data involving dimensions of student epistemic beliefs. Based on an item mean analysis of the quantitative data, the student population was identified by level of epistemic belief: simple, moderate, sophisticated.

Moreover, data analysis included standard Pearson Correlation Co-efficient (*r*) and Factor Pattern analysis using Eigenvectors and Varimax rotation method. In accordance with existing lines of research regarding epistemic belief data, the researchers determined the most efficacious framework for instructional design, pedagogy, and assessment to improve student success in Information Systems coursework.

In this mixed-method investigation a qualitative case study methodology was applied and supported by quantitative data from an undergraduate Information System student population. The diagnostic- prescriptive framework involved a logic chain beginning with collection of data from a specific population regarding student epistemic beliefs. Data analysis and conventional heuristics yielded prescriptive indicators of placement of the sample student population relative to a three-dimensional framework (Figure 1) constructed in concert with accepted learning theories and models (i.e., developmental perspective models and multidimensional perspective models) and the social cognitive theory of self-regulated learning.

Based on the three-dimensional framework, a rubric of 27 design elements for course construction was applied. Course design elements in the rubric accommodate Bloom's hierarchy of cognitive development, synchronous and asynchronous pedagogical strategies, and assessment of learning achievement based on level of epistemic belief (Hannafin & Hill, 2007).

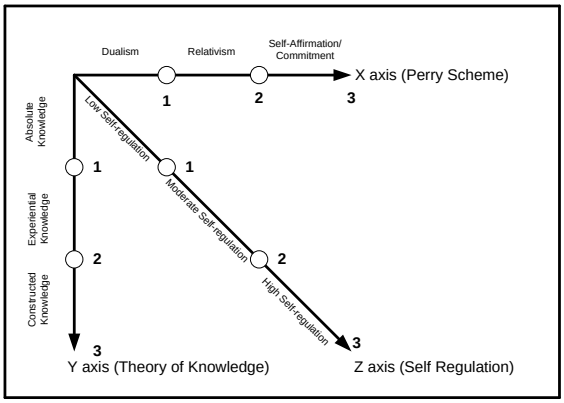

Figure 1: Framework for determination of learner epistemic beliefs profile
Source: Conn, Hall, and Herndon (2010)

As illustrated in Figure 1, three axes representing continuums based on Perry's scheme, theory of knowledge, and levels of self-regulation were abstracted as a cube with 27 distinct co-ordinate dimensions: x1, y1, z1 through x3, y3, z3. This three-dimensional modeling technique was used to identify specific characteristics and profiles for a given population of learners. To create the x-axis (Figure 1), Conn, Hall, and Herndon (2010) grouped Perry's (1970) nine "positions" relative to knowledge and learning into three groups: dualism, relativism, and self-affirmation/commitment. Dualism includes Perry's positions of basic dualism, pre-legitimate multiplicity, and legitimate but subordinate multiplicity (Marra, Palmer, & Litzinger, 2000). Relativism includes full or legitimate multiplicity, contextual relativism, and foreseen commitment; self-affirmation and commitment includes commitment within relativism.

Based on items means from the data collected, the sample learner population was described based on the three-dimensions. For example, a sample population located in the x1, y1, z1 dimension (Figure 2) would characteristically be described by tendencies toward dualistic knowledge and learning, absolute knowledge, and low levels of self-regulation. This non-optimal position would indicate epistemic beliefs of the lowest order (simple), thus requiring instructional design and pedagogy consistent with initial levels of cognition, student motivation, and self-efficacy (Schunk & Pajares, 2005). Any shift in the dimensional positioning would indicate movement in a positive direction, where mutual recursion or other reciprocal relationship may be evident.

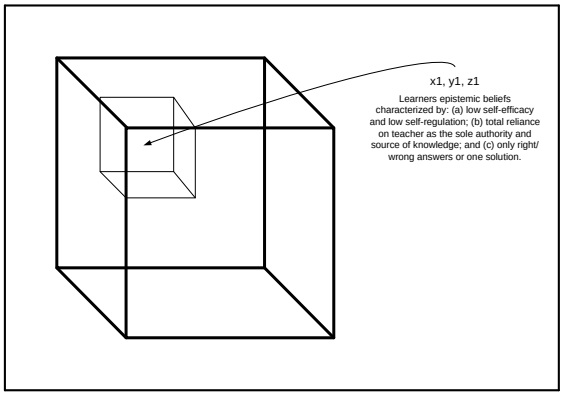

Figure 2: Framework positioning for non-optimal learner epistemic beliefs profile
Source: Conn, Hall, and Herndon (2010)

In another example (Figure 3), a sample population located in the x3, y3, z3 dimension would characteristically be described by tendencies toward self-affirmation/commitment, high levels of meta-cognition, an ability to construct knowledge through collaboration, synthesis, and evaluation, and a high level of self-regulation. This optimal position would indicate highly evolved epistemic beliefs (sophisticated) that could accommodate instructional design and pedagogy consistent with advanced cognition and self-efficacy (Pajares & Kranzler, 1995).

With respect to phenomena involving reciprocity between axes in the framework, a learner population with a cognitive ability to construct new knowledge and act as a source of knowledge would demonstrate higher levels of self-regulation. Conversely, learner populations with higher levels of self-regulation would possess attitudes and epistemic beliefs to construct knowledge, use interdisciplinary approaches in problem solving, and appreciate and incorporate multiple perspectives in the creation of new knowledge.

4. ANALYSIS OF SURVEY DATA

An existing survey instrument was utilized to measure three dimensions: a) students' perception of knowledge and knowing, b) students' level of self-regulation, and c) students' perception of self-efficacy. Thirteen questions measured students' perception of knowledge and knowing, including perceptions of instruction. Eight survey questions related to level of self-regulation. Item responses for these dimensions were obtained using a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Fifteen survey questions related to self-efficacy and asked participants how confident they were in solving various problems and their self-confidence as it related to stating what is known or what is to be determined after reading a sample problem statement.

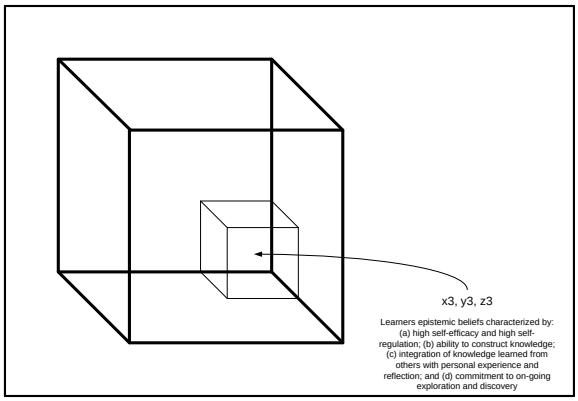

Figure 3: Framework positioning for optimal learner epistemic beliefs
Source: Conn, Hall, and Herndon (2010)

Response options involved a five-point Likert scale ranging from 1 (no self-confidence) to 5 (a high level of self-confidence). The instrument scored a reliability coefficient of 0.86 in this baseline study. Mean scores were computed for each item on the survey. Factor analysis was used to develop three scales for the tree constructs measured in the survey. Chronbach alpha scores were used to ensure reliability for the three scales.

In this study, the sample population (N=28) consisted of undergraduate Information Systems students composed of 14% freshmen, 21% sophomore, 36% juniors, and 29% seniors. Respondents were 21% female and 79% male.

Analysis of Perry's Scheme Sub-scale Data

For item one, students responding with a 4 or 5 (75%) indicated that they agreed or strongly agreed that "A good college instructor often brings up questions that have more than one answer." Therefore, as believed by the student, good (i.e., effective) instruction promotes multiple answers to questions. As a result, a moderate item mean score (3.85 with SD=.854) indicates a preference for instruction originating from multiple sources. The second item, as an indication of tendency, where a response of 4 or 5 (96%) indicated they agreed or strongly agreed that "College instructors should present various ideas on an issue", calculated to a mean of 4.42 with SD=1.09. The students were not skeptical of multiple answers to a single question, thus their tendency is toward hearing all arguments and ideas surrounding an issue. Item three confirms this conclusion where students responding with a 4 or 5 (39%) indicated that they agreed or strongly agreed that "It's not necessary for the instructor to answer all of my questions I ask in class; fellow students can often do it instead" and calculated to a mean of 3.07 with SD=.324.

Further confirmation is seen in item five where students responding with a 4 or 5 (86%) agreed or strongly agreed that "In a good course I would learn as much from fellow students as I would from the instructor" and calculated to a mean of 4.00 with SD=.400. Item seven scored consistently with a mean of 2.67 (SD=.434) when the sample population responded to the statement "In class, I want other students to answer the questions I ask instead of the instructor answering my question." Of students responding with a 4 or 5 (25%), 50% disagreed or strongly disagreed with answers coming from an alternative, convenient source of knowledge (i.e., classmates), indicating emergence to constructivism and away from absolute knowledge.

In concert with movement away from absolute knowledge tendencies, the percentage of students who agreed or strongly agreed with "I like it when an instructor brings up a question that he or she doesn't know the answer to" evaluated to 40%, indicating a transition away from the belief that instructors are authority figures who should know all the answers.

Table 1: Perry's Scheme Sub-scale (x axis)

	Mean	STDEV
Q1. A good college instructor often brings up questions that have more than one correct answer.	3.85	.854
Q2. College instructors should present various ideas on an issue.	4.42	1.09
Q3. It's not necessary for the instructor to answer all of my questions I ask in class; fellow students can often do it instead.	3.07	.324
Q4. I like it when an instructor brings up a question that he or she doesn't know the answer to.	3.07	.400
Q5. In a good course I would learn as much from fellow students as I would from the instructor.	4.00	.969
Q6. I usually like it when my instructor answers a question with "it depends" and follows this statement with a discussion of the topic.	3.82	.666
Q7. In class, I want other students to answer the questions I ask instead of the instructor answering my question.	2.67	.434

For item six, 68% of respondents agreed or strongly agreed that they "usually like it when my instructor answers a question with 'it depends' and follow this statement with a discussion of the topic"; calculated as a mean of 3.82 (SD=.666). As a result, the population generally accepts that knowledge is contextual, indicating relativistic thinking.

In sum, the scores reflected from student responses in the Perry's Scheme Sub-scale (x axis) indicate an evolving preference away from the instructor as an authoritative singular source of knowledge, and outlier tendencies toward multiplicity of knowledge and knowing. The overall item mean for this Sub-scale calculated to be 3.56 (SD=.694) indicating the population holds relativistic beliefs with emerging self-affirmation and commitment tendencies.

Analysis of Absolute Knowledge Sub-scale Data

For item eight, students responding with a 4 or 5 (35%) indicated that they agreed or strongly agreed that "If I heard an instructor say 'we don't know the answer to that', they would worry about taking a class from him/her." As believed by the students, the instructor should not know all, and 39% indicated every question has one correct answer. Moreover, the items together indicate a tolerance for knowledge that is transient or evolving. As a result, a moderate item mean score (2.82 with SD=.464) indicates movement away from a preference for absolute knowledge and knowing.

However item nine, where students responding with a 4 or 5 (14%) indicated that they agreed or strongly agreed that "An instructor who says 'nobody really knows the answer to that' is probably a bad instructor", illustrates a tendency toward evolving and transient knowledge. Combined, item analysis indicates students do not worry if questions have no single answer, and have an emerging acceptance that knowledge does not have to be absolute, dualistic, and unambiguous.

Responses to Item 10 indicate a moderate level of perception of knowledge (item mean of 3.03 with SD=.473) and evolving relativistic tendencies. Of students responding with a 4 or 5 (39%) stated that they agreed or strongly agreed that "There is one right answer for most questions and a good instructor knows it." Nearly half (43%) of the population disagreed or strongly disagreed, indicating strong movement toward experiential knowledge as a basis for learning. This conclusion is supported by item 11 where 32% of respondents agreed or strongly agreed that "A good instructor gives facts and leaves theories out of the discussion." The mean for this item calculated to be 3.17 with SD=.716.

Moreover, item 12 scores lag support and indicate a strong tendency toward absolute knowledge and low self-regulation. Those responding who indicated a 4 or 5 (82%), agreed or strongly agreed with the statement "An instructor's main job is to make sure I learn the course material"; however, the population generally indicates a preference for experiential knowledge that is evolving and transient in nature.

Table 2: Absolute Knowledge Sub-scale (y axis)

	Mean	STDEV
Q8. If I heard an instructor say "we don't know the answer to that" I would worry about taking a class from him/her.	2.82	.464
Q9. An instructor who says "nobody really knows the answer to that" is probably a bad instructor.	3.39	.696
Q10. There is one right answer for most questions and a good instructor knows it.	3.03	.473
Q11. A good instructor gives facts and leaves theories out of the discussion.	3.17	.716
Q12. An instructor's main job is to make sure I learn the course material.	2.07	.440

Analysis of Self-regulation Sub-scale Data

For item 13, students responding with a 4 or 5 (50%) indicated that they agreed or strongly agreed that "It is my own fault if I don't learn the material in a course." As believed by the sample, half take responsibility for their own learning. As a result, a higher item mean score

(3.42 with SD=.448) indicates a preference for experiential knowledge and internal motivation to learn. This conclusion is supported in responses to item 14 where students responding with a 4 or 5 (11%) indicate a decrease in accepting a relationship between level of effort and time-on-task and achievement of learning outcomes. A lower mean (2.39 with SD=.398) indicates lower levels of self-regulation in the population. Avoidance of increased level of effort and time-on-task is generally indicated as a contributing factor to low levels of self-regulation. For this sample, 29% agreed or strongly agreed in item 15 with the statement "Often when I am bored, I like to study"; a mean calculation for this item was determined to be 2.60 with SD=.330.

With respect to focus and attention as indicators of level of self-regulation, 25% of the sample agreed or strongly agreed in item 16 with the statement "During the time I am in class, I often miss important points because I am thinking of other things". Mean response to item 16 calculated as 2.53 with SD= .539. In concert with this response, 33% of the sample agreed or strongly agreed that "I often feel so lazy or bored when I study that I quit before I finish what I planned to do". Item 17 mean calculated to 2.64 with SD=.595. Moreover, ability to stay focused also supported low to moderate levels of self-regulation as 36% of the sample (a mean of 2.78 with SD=.480) indicated agreement or strong agreement in item 18 that "I often find that I have been reading for class but don't know what it was all about". Student response to item 19 indicated that 46% agreed or strongly agreed with the statement "I find it hard to stick to a study schedule"; item mean calculated as 3.10 with SD=.473.

These scores support the conclusion that the sample population demonstrates low to moderate levels of self-regulation. Item 20, the final item in the self-regulation sub-scale, evaluated in support of low self-regulation and absolute knowledge as 43% of students (a mean of 3.07 with SD=.406) surveyed agreed or strongly agreed with the statement "In most cases, I can learn the course material whether the instructor teaches it well or not".

Based on the literature, the authors posit that students with overall higher levels of epistemic belief exhibit more self-regulated behaviors, have less preference for absolute knowledge, are able to evaluate multiple views and approaches toward solving problems and learning theories, do not depend on instructors as a singular source for learning, do not think instructors are authority figures and are the only source of knowledge, and enjoy and willingly contribute to peer discussions and collaborative learning.

Table 3: Self-regulation Sub-scale (z axis)

	Mean	STDEV
Q13. It is my own fault if I don't learn the material in a course.	3.42	.448
Q14. If I don't understand the course material, it is because I didn't try hard enough.	2.39	.398
Q15. Often when I am bored, I like to study.	2.60	.330
Q16. During the time I am in class, I often miss important points because I am thinking of other things.	2.53	.539
Q17. I often feel so lazy or bored when I study that I quit before I finish what I planned to do.	2.64	.595
Q18. I often find that I have been reading for class but don't know what it was all about.	2.78	.480
Q19. I find it hard to stick to a study schedule.	3.10	.473
Q20. In most cases, I can learn the course material whether the instructor teaches it well or not.	3.07	.406

A different set of interventions, course design elements, and instructional strategies would be indicated: (a) if students believed knowledge consists of isolated facts and they did not engage in transfer or considered relationships among facts, (b) if students view instructors as the only possessor of knowledge, and/or (c) if

students were not prepared developmentally to engage in peer collaboration to solve problems and create knowledge.

Student survey data, organized in Tables 1-3, were related to Figure 1, a framework to profile learner epistemic beliefs, via item means. Indicators for the framework x-axis, a range from dualism to self-affirmation and commitment, are seen in Table 1. Further, indicators for the framework y-axis, a range from absolute knowledge to constructivism, are seen in Table 2. Finally, indicators for the framework z-axis, a range from low self-regulation to high self-regulation, are seen in Table 3. Following a means procedure, item means for each table were calculated (Table 4). The item means were projected into three linear ranges that reflect one of three axes positions in the framework: 1, 2, or 3; defined as follows:

Item Means	→	Axis Position
0.00 - 1.67		1
1.68 - 3.34		2
3.35 – 5.00		3

Prescription for this Information Systems student population was achieved by scoring each variable item mean to an axis position according to the (relative) indicators defined in the framework. Based on the item means for each variable (Table 4) and the item means to axes positioning, this case study population of students was defined within the framework as x3, y2, z2. The mean positioning of x3 indicates the learner population is characterized by relativistic tendencies emerging toward self-affirmation/commitment.

According to Perry (1970), this learner population has moved past views that answers are either right or wrong and problems have only one solution, and have begun to adopt a view that knowledge is contextual and transient. The learner in this population is beginning to accept himself/herself as a legitimate source of knowledge and generally does not consider the teacher to be the absolute authority or source of knowledge.

Positioning of the learner population as y2 comes as a result of variable means of 2.78 from Table 4. In this position the learner is characterized as still having some preference for dualistic, binary thinking, but is fully capable of relativism. To advance trajectory, pedagogy and assessment should involve reflecting on previous experience, collaboration with peers, creation of mental models, and application of cognitive schema; learners in this coordinate position can begin to learn how to construct new knowledge if given appropriate tools and directions. Learners in the y2 position also exhibit a predisposition toward experiential learning, can manipulate a body of knowledge to abstract salient points, and can visualize simple abstract concepts and models. Moreover, learners in this position can incorporate nascent experiences into an existing cognitive framework or reference and accommodate new theories, concepts, and schema (Perry, 1981). Learners at this higher cognitive level also are transitioning from passive to active learners and generally learn by doing.

Table 4: The MEANS Procedure

	N	Mean	STDEV
Table 1: Perry's Scheme Sub-scale (x axis)	28	3.56	.694
Table 2: Absolute Knowledge Sub-scale (y axis)	28	2.78	.633
Table 3: Self-regulation Sub-scale (z axis)	28	2.81	.519

The third axis position, z2, indicates that the learner population experiences low to moderate self-regulation. Learners in this population are guided by moderate cognitive learning strategies, capable of learning in blended or hybrid approaches to instruction, and increasing levels of motivation to learn. To positively alter trajectory, increased meta-cognitive instructional strategies provide learners with a proven path or plan for how to learn, based on prior learning accomplishments. The z2 learner population can develop a diminished need for faculty in the learning process, demonstrate increased persistence toward difficult problems, and alter learning strategies in response to levels of success in meeting learning goals and objectives. This learner population also is characterized by increased self-awareness, higher levels of self-efficacy, and some ability to monitor, evaluate, and alter individual performance, initiative, time-on-task, and level of effort.

The student population is now defined such that design elements can be applied in the construct of a course to more fully engage and accommodate the learner population, or to develop a strategy to alter the trajectory of the learner population toward the optimal position of x3, y3, z3. Once the coordinate position of the learner population is determined, design elements (Tables 5, 6, and 7) with respect to student profile, pedagogical strategies, and assessment mechanisms can be applied via instructional design.

Essentially, mapping this student population position within the epistemic beliefs framework (Figure 1) to course design elements (Tables 5, 6, and 7) provides guidance for course design that most efficaciously meets the needs of the learner population. Moreover, as noted previously, the methodology can be used to establish a trajectory of design to move a given learner population from its defined position to a more optimal position within the framework.

6. APPLYING RUBRICS IN INSTRUCTIONAL DESIGN

The subject of this case study, a population (N=28) of first-year undergraduate students involved in a state university Information Systems program, was evaluated through survey item mean analysis to a coordinate position of x3, y2, z2 with respect to the framework for determination of learner epistemic beliefs profile (Figure 1). Applying the rubric to first identify the student population's epistemic belief profile (Table 5) suggests the class has emerged from dualistic to relativistic and self-affirmed tendencies, is capable of contextual and integrative problem solving, can appreciate multiple world views, and possesses a capacity for critical analysis.

Moreover, the student population has emerging tendencies toward intrinsic motivation, has developed and somewhat embraced a tolerance for ambiguity, and has an emerging sense of the contextual nature of knowledge. Also, the student population most appreciates knowledge based on practical applications. Data analysis also indicates the student population evaluates at a low to moderate level of self-regulation, shows tendencies toward active learning, can differentiate between faculty dependent and student dependent learning, and is open to collaborative learning environments.

Table 5: Student Epistemic Profile

X-Axis Perry Model	Y-Axis Theory of Knowledge	Z-Axis Self Regulation
1 Dualistic Binary problem solving Concrete world view Does not acknowledge multiple perspectives No critical analysis Motivation is extrinsic Does not see the "big picture" Intolerant to ambiguity	1 Knowledge is absolute Knowledge is based on scientific reasoning and natural laws	1 Low self-regulation Passive learner Faculty dependent learner Does not value collaborative learning
2 Relativistic Contextual problem solving Appreciates multiple world views Capacity for critical analysis Motivation may be extrinsic/intrinsic Sees the "big picture" Tolerant to ambiguity	2 Knowledge is relative Knowledge is based on practical applications	2 Moderate self-regulation Active/passive learner Faculty/student dependent learner Open to collaboration learning
3 Self-affirmative/committed Integrative problem solving Appreciates and incorporates multiple perspectives in the development of world view Employs highly cognitive, critical thinking skills Motivation is intrinsic Sees self in the "big picture" Embraces ambiguity	3 Knowledge is constructed and grounded in integrative, interdisciplinary perspectives	3 High self-regulation Active learner Student dependent learner Seeks opportunities for collaborative learning

Source: Dr. Michael Herndon, Virginia Polytechnic Institute and State University

Applying the rubric to identify applicable pedagogical strategies (Table 6) suggests initiation of some class discussion with an encouraging tone for students to participate in the discussions. Students should be encouraged to contribute to the base of knowledge and faculty should develop blended approaches for the dissemination of knowledge, such as a mixture of face-to-face instruction with online instruction. Moreover, faculty should utilize moderate cognitive learning strategies and develop assignments to diminish faculty responsibility for learning.

Table 6: Pedagogical Strategies

X-Axis Perry Model	Y-Axis Theory of Knowledge	Z-Axis Self Regulation
1 Faculty centered lectures Little to no class discussion	1 The faculty are the source of knowledge Synchronous dissemination of knowledge Controlled by faculty	1 Utilize low cognitive learning strategies Design only in-class learning opportunities Avoid an openness to change in instruction
2 Initiate some class discussion Encourage students to participate in class discussions	2 Allows faculty and students to contribute to the base of knowledge Develop blended approaches for the dissemination of knowledge (e.g. a mixture of online and face to face instruction)	2 Utilize moderate cognitive learning strategies Develop assignments to diminish faculty responsibility for learning
3 Foster robust class discussions Empower students with a large degree of ownership for the success of the class	3 The construction of knowledge is student driven Asynchronous dissemination of knowledge Create knowledge through peer learning (e.g., discussion boards, group projects, and other collaborative experiences)	3 Implement meta-cognitive learning strategies Encourage both in and out-of-class learning opportunities Develop assignments that facilitate the adaptability to change in instruction

Source: Dr. Michael Herndon, Virginia Polytechnic Institute and State University

Applying the rubric to determine the most appropriate assessment mechanisms (Table 7) for the student population indicates use of multiple choice test items. Student populations, as in this case, that have emerged from dualistic, binary thinking to relativistic in-context

thinking can relate to multiple choice test items where relativistic thinking is assessed.

Table 7: Assessment Mechanisms

X-Axis Perry Model	Y-Axis Theory of Knowledge	Z-Axis Self Regulation
1 True/False Test Items	1 Assessment tools elicit rote responses from student	1 Student bears no responsibility for assessing individual progress
2 Multiple Choice Test Items	2 Assessment tools may encourage some degree of critical thinking and synthesis	2 Student takes some responsibility in gauging individual progress
3 Group case study research Utilizes peer reviewed exercises Makes use of simulation exercises	3 Assessment tools allow for the building of new knowledge created by the student	3 Active Learner Employs reflective writing assignments (e.g., e-portfolio, self authorship, and independent study) Student takes an active role in assessing individual progress, has a realistic appraisal of intellectual abilities and makes room for improvement by participating in co-curricular activities

Source: Dr. Michael Herndon, Virginia Polytechnic Institute and State University

Also, assessment tools and mechanisms should encourage some degree of critical thinking and synthesis to support an emerging sense of the contextual nature of knowledge. Moreover, this student population should take some responsibility for gauging individual progress through assessment mechanisms such as portfolio assessment, reflection and self-assessment, and comparative evaluations to one's peers.

7. FINDINGS AND RECOMMENDATIONS

This baseline study establishes a priori knowledge regarding the level of epistemic belief among a cross-sample of undergraduate Information Systems students. As seen in Figure 4, the student population demonstrates a moderate level of epistemic beliefs with respect to perceptions of knowledge and knowing (Q1-Q13), simple to moderate levels of epistemic beliefs with respect to self-regulation (Q14-Q32), and (increasing) moderate levels of epistemic beliefs with respect to self-efficacy (Q33-Q45).

Additional research is needed to establish longitudinal views of Information Systems students by year in school with subsequent assessment data collected to establish pre and post programmatic results as an indicator of improved levels of epistemic belief. In this case study, the student population demonstrates tendencies toward a trajectory to increased levels of epistemic beliefs.

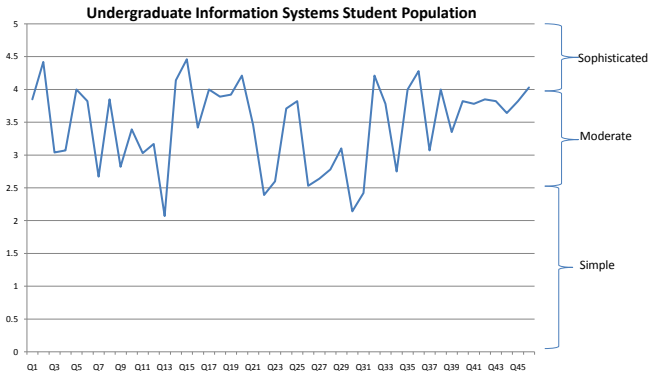

Figure 4: Item data graphed to illustrate levels of epistemic belief

Other general findings in support of conclusions include the need to alter and support learning environments, strategically align pedagogical strategies, and employ more appropriate assessment mechanisms in response to the Information System student population's current levels of epistemic belief. For example, learners in a collaborative problem solving environment receive feedback and comments from peers, and from the teacher on the steps of planning, implementing, and executing problem solving processes rather than only receiving feedback from the teacher on their performance. Therefore, peer pressure, as a motivating factor, may lead students to perform higher level cognitive functions. In addition, social constructivism (Pajares, 2002) suggests that the exchange of critical feedback among peers as well as from the instructor can encourage students to modify their work.

This study promoted the Scholarship of Teaching and Learning (SoTL) and extended the state of knowledge in Human Performance Technology by contributing to and exemplifying accepted learning theories and models. Students' perceptions of various aspects of teaching and learning in a course play an important role in their engagement and performance (Schommer, 1993). Ravert and Evans (2007) showed that expecting students at earlier stages of development to learn from courses based on principles of negotiation, shared construction, and peer-to-peer learning could be problematic. Therefore, if tools employed in teaching and learning or instructional design run contrary to

students' epistemic beliefs, the result could be student frustration and distress. As a result, the instructional design and pedagogical strategy should address these issues during the course design phase.

In this report a study examining student epistemic beliefs was presented. The researchers offer the following suggestions for further discovery to faculty, instructional designers, and administrators who develop curricula for undergraduate Information Systems students entering college with undetermined levels of epistemic belief:

i. The authors suggest that faculty consider the use of epistemic belief data when developing course syllabi. Instructors should determine if the course design is structured in such a way to challenge and positively alter students' epistemic beliefs or only reinforce current epistemic beliefs.

ii. Epistemic beliefs among students were discussed in this research; however, examining the influence of faculty members' epistemic beliefs on students' epistemic beliefs is fertile ground for future research endeavors. Little to no scholarship has been devoted to this line of inquiry.

iii. This case study involved students in undergraduate Information Systems studies. The quantitative findings of this research may be generalized to students in multiple disciplines and year of study, as they relate to epistemic beliefs. Follow up study is needed to apply this methodology to broader boundaries.

iv. Faculty should apply the rubrics for student epistemic profile, pedagogy, and assessment in support of instructional design for Information Systems courses.

v. Research should further compare and study epistemic beliefs across disciplinary boundaries. The results will inform new efforts and planning phases in instructional design and curricula quality improvement initiatives.

vi. While the authors used one proven instrument to assess the epistemic beliefs in this case study, multiple tools exist. Course developers should choose an instrument that is most appropriate for their population and then apply the findings as was done in this case study.

vii. Finally, the authors suggest that the study of epistemic belief should occur in a longitudinal fashion. Institutions can gauge students' epistemic beliefs at the beginning of their first year and periodically assess shifts and trends among students throughout the undergraduate experience. This process can allow faculty members to fine tune course design, academic activities and assignments, and course assessments, promoting growth in academic performance among their students.

8. REFERENCES

Bandura, A. (1984). Recycling misconceptions of perceived self-efficacy. *Cognitive Therapy and Research,* 8, pp. 231-255

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall

Bloom, B., Engelhart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). Taxonomy of educational objectives. Handbook 1: Cognitive domain. New York: McKay.

Buehl, M., Alexander, P., & Murphy, P. (2002). Beliefs about schooled knowledge: Domain specific or domain general? Contemporary Educational Psychology, 27, pp. 415-449.

Clark, R. C., & Mayer, R. E. (2003). E-learning and the science of instruction. San Francisco: Jossey-Bass.

Conn, S., Hall, S., & Herndon, M. (2010), Student epistemic beliefs as a catalyst for online course design: a case study for research-based eLearning, In 'Cases on building quality distance delivery program: Strategies and experiences' – Huffman, S., Albritton, S., and Wilmes, B. (editors). Hershey, PA: IGI Global.

Creswell, J. & Clark, V. (2007). Designing and conducting mixed methods research. Thousand Oaks, CA: Sage Publications.

Hammer, D.H., & Elby A. (2002). On the form of personal epistemology. In B.K. Hofer & P.R. Pintrich (Eds.) Personal epistemology: The psychology of beliefs about knowledge and knowing, pp. 169 – 190. Mawah, NJ: Lawrence Erlbaum Associates.

Hannafin, M.J., & Hill, J.R., (2007). Epistemology and the design of learning environments. In R.A. Reiser & J.V. Dempsey Trends and Issues in Instructional Design and Technology 2nd ed., Pearson: Upper Saddle River, NJ.

Hofer, B.K. (2000). Dimensionality and disciplinary differences in personal epistemology, Contemporary Educational Psychology, 25, pp. 378-405.

Hofer, B. K., & Pintrich, P. R. (1997). "The development of epistemological theories: beliefs about knowledge and knowing and their relation to learning," Review of Educational Research, 67 (1), pp. 88-140.

Hofer, B. K., & Pintrich, P. R. (2002). Personal Epistemology: The psychology of beliefs about knowledge and knowing, Mahwah, New Jersey: Erlbaum Associates.

King, P.M., & Kitchner, K.S. (1994). Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults. San Francisco: Jossey-Bass.

Knight, L.V., & Mattick, K. (2006). "When I first came here, I thought medicine was black and white: making sense of medical students' ways of knowing," Social Science & Medicine. (63), pp. 1084-1096.

Kuhn, D. (1993). Science as argument: Implications for teaching and learning scientific thinking. Science Education, 77 (3), pp. 319-337.

Marra, R. M., Palmer, B., & Litzinger, T.A. (2000). "The effects of a first-year engineering design course on student intellectual development as measured by the Perry Scheme," Journal of Engineering Education, 89 (1) pp. 39-46.

Marra, R.M., & Palmer, B. (2004). Encouraging intellectual growth: Senior college student profiles, Journal of Adult Development, 11 (2), pp. 111-122.

Mayer, R. E. (2002). Cognitive theory and the design of multimedia instruction: An example of the two-way street between cognition and instruction. New Direction for Teaching and Learning, 89, pp. 55-71.

Muis, K. R. (2007). The role of epistemic beliefs in self-regulated learning, Educational Psychologist, 42 (3), pp. 173-190.

Muis, K., Bendixen, L. & Haerle, F. (2006). Domain-generality and domain-specificity in personal epistemological research: Philosophical and empirical reflections in the development of a theoretical framework. Educational Psychology Review, 18, pp. 3-54.

Pajares, F. (2002). Overview of social cognitive theory and of self-efficacy. [Online]. Retrieved September 13, 2009 from http://www.des.emory.edu/mfp/eff.html.

Pajares, F., & Miller, M. D. (1994). "Role of self-efficacy and self-concept beliefs in mathematical problem solving: a path analysis," Journal of educational psychology, 86 (2), pp. 193-203.

Pajares, F., & Kranzler, J. (1995). "Role of self-efficacy and general mental ability in mathematical problem-solving: A path analysis," ED387342, Paper presented at AERA San Francisco, CA., April 18-22.

Perry, W. G. (1970). Intellectual and ethical development in the college years: A scheme. New York: Holt, Rinehart & Wilson.

Perry, W. G. (1981). "Cognitive and ethical growth: The making of meaning. In A. Chickering," (Ed.), The modern American college, pp. 76-116. San Francisco: Jossey-Bass.

Piaget, J. (1950). Introduction a l'epistemologie genetique. Paris: Presses University de France.

Pintrich, P. R., & Schunk, D. H. (2002). Motivation in education: Theory, research, and applications (2nd ed.), Prentice Hall Englewood Cliffs, NJ.

Ravert, R. D., & Evans, M. A. (2007). College student preferences for absolute knowledge

and perspective in instruction: implications for traditional and online learning environments, The Quarterly Review of Distance Education, 8 (4), pp. 321-328.

Report to Congress: Improved data on program costs and guidelines on quality assessments needed to inform federal policy (2004). Retrieved October 15, 2009 from http://www.gao.gov/new/items/d04279.pdf.

Ryan, M.P. (1984a). Conceptions of prose coherence: Individual differences in epistemological standards. Journal of Educational Psychology, 76 (6), pp. 1226-1238.

Ryan, M.P. (1984b). Monitoring text comprehension: Individual differences in epistemological standards. Journal of Educational Psychology, 76 (2), pp. 249-258.

Schoenfeld , A. (1983). Beyond the purely cognitive: Belief systems, social cognitions, and metacognitions as driving forces in intellectual performance. Cognitive Science: A Multidisciplinary Journal, 7 (4), pp. 329-363.

Schoenfeld, A.H. (1985). Mathematical problem solving. San Diego, CA: Academic Press.

Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. Journal of Educational Psychology, 82, pp. 498–504.

Schommer, M., Crouse, A., & Rhodes, N. (1992). Epistemological beliefs and mathematical text comprehension: Believing it simply does not make it so. Journal of Educational Psychology, 82, pp. 435-443.

Schommer, M. (1993). Epistemological development and academic performance among secondary students. Journal of Educational Psychology, 85 (3), pp. 406-411.

Schunk, D. H. (1981). Modeling and attributional effects on children's achievement: A self-efficacy analysis. Journal of Educational Psychology, 73 (1), pp. 93-105.

Schunk, D. H. (1983). Ability versus effort attributional feedback: Differential effects on self-efficacy and achievement. Journal of Educational Psychology, 75, pp. 848-856.

Schunk, D. H. (1984). Sequential attributional feedback and children's achievement behaviors. Journal of Educational Psychology, 76, pp. 1159-1169.

Schunk, D. H. (1995). Self-efficacy and education and instruction. In J. E. Maddux (Ed.), Self-efficacy, adaptation, and adjustment: Theory, research, and application, pp. 281-303. New York: Plenum Press.

Schunk, D. H., & Pajares, F. (2002). The development of academic self-efficacy. In W. Wigfield & Eccles, J. S. (Eds.), Development of achievement motivation, pp. 15-31. San Diego, CA: Academic Press.

Schunk, D. H., & Pajares, F. (2005). Competence perceptions and academic functioning. In A. J. Elliot & C. S. Dweck (Eds.), Handbook of competence and motivation, pp. 85-104. New York: Guilford Press.

Editor's Note:

This paper was selected for inclusion in the journal as an ISECON 2010 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2010.

.