Exploratory Factor Analysis for the Survey of Epistemic Beliefs for Discipline-Based Knowledge Creation

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Abstract: The study of personal epistemology has been very much confined to the dimensions of nature of knowledge and nature of knowing. Given the technology driven knowledge society that we face today, it is necessary to cultivate knowledge creators among 21st century learners. This study proposed to study personal epistemology from the perspective of knowledge creation. A new questionnaire the survey university students epistemic beliefs for discipline-based knowledge creation was crated. Through exploratory factor analysis and internal consistency analysis, the survey was found to possess construct validity and good reliability. This new questionnaire can be the basis for a range of new studies on personal epistemology.

Keywords: Epistemological beliefs, exploratory factor analysis, discipline-based

1. Introduction

Research in personal epistemological beliefs investigates one's belief about the nature of knowledge and knowing. This field of study within the broader context in educational psychology was initiated by Perry's (1970) investigation of Harvard male students' stage like progression in their epistemological beliefs. The students were interpreted to develop through four major stages which are progressively the dualist, multiplist, relativist and committed relativist. The nature of knowledge was correspondingly seen as progressing from either right or wrong to the stage where there are legitimate multiple views; subsequently to a stage of all claims are relative and thus there isn't absolute right/wrong; and finally to committing to a personally held conviction about knowledge without having absolute objective proof. These qualitative interpretations have been further strengthened by later researchers (for example, Belenky et al., 1986; King & Kitchener, 1994).

Building on these earlier work, Schommer (1990) initiate the quantitative approach of researching personal epistemology. She created the first epistemological belief questionnaire and discovered that students' epistemological beliefs are associated with their reading comprehension. The dimensions of epistemological beliefs in the questionnaire were beliefs about the Certainty of knowledge (i.e. whether knowledge changes over time), Simplicity of knowledge (knowledge as isolated bits to integrated concepts), Source of knowledge (whether knowledge are from experts and authority or from within oneself through observation and reason), Quick knowledge (learning as happening quickly or not at all) and Fixedness of knowledge acquisition (learning ability as fixed at birth to life-long improvement) (see also Schommer-Aikens, 2002). The inclusion of quick knowledge and fixed learning ability has been questioned as they are dimensions of learning beliefs rather than epistemological beliefs (Hofer & Pintrich, 1997). Nonetheless, Schommer inspires many

researchers to develop quantitative questionnaire (see for example Chan & Elliott, 2004; Schraw, Bendixen & Dunkle, 2002). Subsequent quantitative studies reveal more influences of epistemological beliefs on constructs associated with internet-based learning and self-regulated learning (Stromoso & Braten, 2010); students' learning approaches and academic achievement (Cano, 2005); students' performance on resolving controversial issues (Mason & Boscolo, 2004) and learning targeted at creating conceptual change among students (Qian & Alvermann,1995). Generally, sophisticated epistemological beliefs that see knowledge as uncertain and knowing rely much on personal sense making are associated with good learning practices such as deep approach to learning.

The interest to study Asian students' epistemology emerged around the turn of the century with Chan and Elliott (2004) creating a questionnaire based on Asian context. Earlier attempts using Schommer's questionnaire have raised many questions about its construct validity for the Asian learners (see Wong & Chai, 2010). Recent research includes Chai, Deng, Wong and Qian's (2010) study of China undergraduates' general epistemological beliefs and their scientific epistemological beliefs. These authors surface that the undergraduates' epistemological beliefs are associated with the disciplines they are studying. Undergraduates from discipline associated with the hard sciences are more likely to adopt an objectivist epistemological stance while their counterparts from the social sciences or humanities are more inclined towards relativist stance.

An important gap in current research on personal epistemology that has been surfaced is the lack of inclusion of wider consideration of knowledge itself. Wong and Chai (2010) pointed out that current research in personal epistemology seems to be confined to the traditional the Greek word *episteme,* which is equivalent to our current understanding of scientific knowledge. They argue that *episteme* in early Greek literature are commonly contrasted with *techne* or art/craft and *poiesis* or making/inventing/transforming. Thus, they suggested that a more adequate grasp of epistemology today might have to incorporate elements of *techne* and *poiesis.* Their suggestion seems to correspond with Cross's (2007) proposed realms of knowledge as Sciences, Humanities and Design. Tsai, Chai, Wong, Hong and Tan (2013) has also proposed that it is important to foster design epistemology among today's learners as they consider design-oriented epistemological outlook as critical for the 21st century knowledge society. The key challenge posed by the 21st century knowledge society on education is to cultivate workers in the knowledge society capable of creating usable knowledge leveraging on the meaningful use of technology, and not just knowledge that are governed by academic interests concerning the "truth" (Bereiter, 2002). In this light, current research on personal epistemology is apparently in need of means to assess students' epistemology that are associated with their view of creating knowledge rather than acquiring knowledge. In other words, current quantitative research of personal epistemology seems to be confined to understanding knowledge as scientific knowledge and the dimensions of epistemology studied are about certainty of knowledge and source of knowledge. This paper adopts a radically different stance to the study of personal epistemology that sees knowledge as dynamic creation of *episteme, techne and poiesis.* In this sense, knowledge is definitely uncertain and created by self (likely in the context of communities of practice), through the employment of different disciplines and transdisciplinary methodology. This study is an initial attempt by the authors to create an instrument to investigate if the learners in the 21st century are able to discern the various knowledge creation traditions they have been exposed to through broad base education.

2. Method

2.1 Participants

Participants (N=250) comprised of university students from three universities in Taiwan. The students were from a diverse range of background including account, business management, education, engineering and social sciences. There were 110 male students. There were 87, 47, 48, 30 year 1 to year 4 undergraduate students respectively and 38 postgraduate students.

2.2 Materials

An 18-item questionnaire was designed by the authors who were trained in different majors, namely literature, science and technology. Three dimensions of discipline-based epistemological beliefs were studied including scientific knowledge creation (SKC), artistic knowledge creation (AKC), design oriented knowledge creation (DKC), with six items in each factor. The authors brainstormed and discussed their discipline-based knowledge creation practices and formulated items that represent the practices. The 18 items were then subjected to review by a philosopher and an education professor before being pilot tested with an initial group of (N=20) university students for item clarity. Each item required respondents to indicate via a 7-point Likert scale the degree to which they found they are agreeable (1 = Strongly disagree to 7 = Strongly agree).

3. Results

3.1 Exploratory Factor Analysis

Principal Axis Factoring with Varimax rotation of the data extracted three factors of 14 items with factor loading of .50 and above (Please see Table 1). Kaiser-Meyer-Olkin measure of sampling adequacy was .88 and Bartlett's test of sphericity was significant (χ^2 (91) = 1258.12, $p < .001$). The total variance explained was 58.1%. The overall internal consistency of the all 14 items was 0.87. Individual factor Cronbach Alphas were 0.72 (SKC) , 0.79 (DKC) and 0.83 (DKC). Two items from SKC and DKC were removed due to insufficient factor loading. The mean scores and standard deviations of the 3 factors were M=5.32 (SD=.88), M=5.75 (SD=.79), 5.82(SD=.72) for AKC, DKC and DKC respectively.

Table 1: Exploratory Factor Analysis

	AKC	DKC	SKC
A3 Artistic creation requires professional experiences to represent social cultural phenomenon	.786		
A4 Artists express deep human experiences through creative thinking	.754		
A2 Artists create artifacts that can awake deep aesthetic experience among its audiences.	.711		
A1 Artistic thinking is focused on transforming subjective experiences into the art forms that can create empathic experiences.	.650		
A5 The knowledge quest for the arts is associated with inquiry about social cultural phenomenon	.650		
A6 Artists give meaning to the artifacts through innovative use of medium	.603		
D5 the designer's thought are focused on finding corresponding solutions for the problem.		.805	
D4 Designers approach the problems they are concerned with from various angle to find possible improvements.		.742	
D6 Designers seek to create meaningful solutions to complex real world problems.		.663	

D3 Designers usually produces many ideas to explore possibilities.		.649	
S1 Scientists develop explanation of natural phenomenon through analytical thinking.			.789
S3 The methodology of scientific research is reliance on certain degree of objectivism.			.703
S2 The creation of scientific knowledge is dependent on experiments.			.673
S5 Scientists construct theory to explain causal relationship.			.590
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 5 iterations.			

Discussion

The main goal of this paper was to design an instrument that can be used to explore college students' epistemic beliefs concerning knowledge creation from three generic disciplines, namely, natural science, human science, and design science based on Cross (2007) and Tsai et al (2013) proposal. The results support that the newly design instrument possesses adequate construct validity and reliability for future studies in personal epistemology. The newly designed instrument offers a useful measure for assessing students' disposition for knowledge creation rather than being confined to earlier instrument that measured the certainty of knowledge and source of knowledge (see Schommer, 1990; Chan & Elliott, 2004; Chai et al., 2010). The new instrument may help to provide some possible explanations concerning how students with different majors see and work with knowledge in a very different fashion. It may also be used to assess how students understand different forms of knowledge creation. The mean scores obtained for this study indicate that students seem to understand the scientific ways of knowledge creation more than they understand the design-oriented knowledge creation and artistic ways of knowledge creation. Follow up qualitative studies is necessary to unpack the results.

As we are entering into a knowledge society that highly values collaborative knowledge creation supported by advancement in technology, there is also a corresponding demand for universities to educate and cultivate more creative knowledge workers with competencies to address 21st-century societal, economical, and environmental problems. To this end, it is essential for educators to have a clear understand of students' epistemological beliefs and dispositions so as to better help them develop their creative potentials for identifying and solving future problems. The questionnaire designed in this study serves as a useful tool in helping us understand the different epistemic views students from different disciplines may possess. The design of this instrument also has implications for educators' designing more innovative pedagogy which targets to help foster creative 21st-century competencies among students' with different disciplined backgrounds. It may be used to assess pre-and-post intervention changes in epistemic beliefs among the students and also cross sectional studies to map out the development of students' epistemic beliefs in knowledge creation. Future studies will further validate this instrument using a larger pool of participants for sustained improvement.

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