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BOARD #171: Understanding Epistemic Beliefs of Chinese Students to Bridge the Cultural Gaps in Teaching and Learning

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Jing Wang

Understanding Epistemic Beliefs of Chinese Students to Bridge the Cultural Gaps in Teaching and Learning

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Abstract

Understanding students' epistemic beliefs (EB) – how they perceive knowledge and learning – is crucial for effective teaching. However, traditional tools like the Epistemological Beliefs Assessment for Physical Science (EBAPS) may not fully capture the beliefs of culturally diverse students, particularly those from non-Western backgrounds. This study examines Chinese university students' epistemic beliefs and highlights the need for culturally responsive adaptations to both pedagogy and BE assessment tools such as the EBAPS.

We present data from one Chinese university showing that, while overall EBAPS scores are comparable to those of U.S. students, Chinese students score significantly lower on the Evolving Knowledge and Source of Ability to Learn axes. Additionally, weaker inter-item correlations among certain items suggest the current EBAPS may not accurately reflect Chinese students' EB.

To address these gaps, we conducted interviews and introduced new survey items designed to capture naïve dialecticism – a cognitive pattern emphasizing contradiction, change, and holism – which influences Chinese learners' perspectives on knowledge and learning. We show that students' limited understanding of epistemology and learning science may contribute to the belief that scientific knowledge is largely fixed and that success in science depends more on innate ability than on strategic effort. Moreover, the holistic and moderate stance shaped by naïve dialecticism may obscure inter-item correlations related to the structure of scientific knowledge.

Introduction

Understanding students' epistemic beliefs (EB) – their perceptions about the nature of knowledge and the process of learning – is crucial for creating effective educational experiences[1]. These beliefs influence how students approach learning at both cognitive and metacognitive levels, shaping their strategies for individual learning tasks[2]. More sophisticated EB – where students view knowledge as evolving rather than fixed, interconnected rather than discrete, and learning ability as malleable rather than innate – are positively associated with academic performance, critical thinking, and deep learning strategies[2]. Therefore, assessing students' EB and tailoring education to support their development is essential for enhancing teaching and learning efficacy.

While epistemic beliefs are developmental, multidimensional, and to some extent domain-specific, they are also shaped by the cultural and educational contexts in which students are raised[3]. Much of the existing research on EB has been conducted in Western contexts, but it is increasingly recognized that students from non-Western backgrounds, such as those in China, may hold beliefs that differ significantly from their Western counterparts[4]. Compared to Western students (primarily from the USA), Chinese students are more likely to perceive knowledge as certain and the ability to learn as innate[5]. Such differences in epistemic beliefs may shape Chinese students' unique perceptions of and responses to modern teaching methods, such as active learning and reflective thinking, in Western classrooms. These beliefs could influence how students engage with learner-centered approaches, potentially affecting their adaptability and overall learning outcomes.

Moreover, commonly used tools for assessing epistemic beliefs, such as the widely used Epistemological[1] Beliefs Assessment for Physical Science (EBAPS)[6], may not adequately capture the unique characteristics of students with different cultural and educational backgrounds. This limitation further hinders instructors' ability to gain a comprehensive understanding of their students' epistemic beliefs across diverse cultural backgrounds, thereby challenging their capacity to adapt teaching strategies for a more inclusive and culturally responsive educational approach.

This study examines the epistemic beliefs of Chinese university students majoring in education for sciences and discuss several factors that may have contributed to the EB difference between Chinese students and American samples. In addition to factors reported in the literature, e.g. the Confucian and Taoism tradition and the exam-oriented education, we propose additional factors such as naïve dialecticism[7] and students' epistemology knowledge of science. We also evaluate the suitability of the EBAPS for assessing the EB of Chinese students. We propose potential revisions to better reflect their unique cultural and educational contexts.

Research Question

1 In this paper, the terms "epistemic belief" and "epistemological belief" are used interchangeably, as the subtle differences between them are not the focus of this study.

Despite the importance of EB in shaping learning outcomes, there is a lack of research examining the epistemic beliefs of Chinese university students, particularly those from mainland China in the past decade. Furthermore, no studies in the English literature have reported the application of the EBAPS in this context. Given the importance of epistemic beliefs and changes in the educational landscape over the past decade, this study seeks to address the following research questions:

1. What are the epistemic beliefs of Chinese university students, and how do they differ from those of Western students?
2. What factors might contribute to these differences in the epistemic beliefs of Chinese students?
3. What are the limitations of the EBAPS tool for assessing Chinese students, and how can it be revised to better reflect their epistemic beliefs?

While these questions aim to provide long-term insights into improving science education in China, the findings from this study also hold relevance for broader contexts, particularly for enhancing science teaching in multicultural classrooms where students with diverse cultural and educational backgrounds share the learning environment.

Literature Review

A. Epistemic Beliefs

The developmental trajectory of students' view towards knowledge, from a dualistic perspective (knowledge as absolute) to a relativistic one (knowledge as evolving and contextual), was introduced in Perry's seminal work in 1970[8]. This framework for describing students' epistemic beliefs was later refined by Schommer (1990)[9] to include multiple dimensions that exist semi-independently, falling into two main domains: beliefs about the nature of knowledge and beliefs about the process of knowing. In a landmark review, Hofer and Pintrich (1997)[1] proposed key theoretical and methodological issues in the study of EB, advocating for clear definitions, robust measurement tools, and studies linking EB to students' actual academic performance. They also highlighted the contextual nature of EB, noting that factors such as disciplines, classroom structures, and cultural contexts can shape these beliefs. Since then, many studies have shown that more sophisticated EB are positively linked to students' academic performance, critical thinking, and the use of deep learning strategies[2], [10], [11]. Instructional methods designed to foster more sophisticated EB have also shown positive effects on learning outcomes, including gains in conceptual understanding[12], use of deep learning strategies, and problem-solving performance[13].

B. Cross-Cultural Perspectives on Epistemic Beliefs

Cultural and educational contexts play a significant role in shaping epistemic beliefs. In Western educational systems, particularly in the United States, reflective and analytical thinking are emphasized through inquiry-based active learning approaches, fostering beliefs that knowledge is tentative, evolving, and co-constructed[4]. In contrast, Chinese education tends to be more teacher-centered and exam-oriented[14], emphasizing mastery of content, which fosters a belief that knowledge is fixed and should be passed down from authoritative figures.

The differences in educational systems within Chinese culture provide a compelling illustration of how education influences EB. For instance, a study comparing students' EB in mainland China and Taiwan highlights these contrasts. Although both regions share the same cultural roots, their educational systems have diverged significantly since 1950, with Taiwan adopting a system more aligned with the U.S. model. Research[15] reveals that high school students from mainland China are less likely to believe in "the invented and creative nature of science" and "the changing and tentative nature of scientific knowledge" compared to their Taiwanese counterparts.

The Chinese cultures, influenced by Confucian and Taoist traditions which emphasize harmony, authority, and holistic thinking[16], [17], may also help shape Chinese students' views of knowledge as deriving primarily from authoritative sources, leading them to perceive it as more fixed and certain.

As a result, Chinese students not only score differently on the same EB scales, but the structural factors of EB extracted from Chinese samples also differ significantly. Chan and Elliott[4] suggest that these differences underscore the need for modifications to existing EB scales. Such adjustments are essential to capture the unique features of EB in Chinese students and to design more inclusive and culturally responsive pedagogical strategies.

C. Naïve dialecticism

In addition to the aforementioned cultural and educational factors, we propose naïve dialecticism as an additional factor that influences both students' epistemic EB and their performance on EB scales. Summarized in the seminal work of Peng and Nisbett[17], naïve dialecticism underpinning Chinese dialectical epistemology mainly consists of three principles. The first is the "Principle of Change", which asserts that "reality is a process" and so are the concepts reflecting it. The second component, the "Principle of Contradiction", emerging as a logical consequence of the Principle of Change. Since reality is always changing, it is inherently not "precise or cut-and-dry but full of contradictions." Together, the Principle of Change and the Principle of Contradiction lead to the third principle, the "Principle of Relationship or Holism", which posits that "anything regarded in isolation is distorted because the parts are meaningful only in their relations to the whole" and that "everything exists in the mystical integration of *yin* and *yang*".

In contrast, dialectical thinking in Western philosophy, while also acknowledging the interconnected and ever-changing nature of things, emphasizes integration and synthesis within the framework of the "law of noncontradiction." Consequently, the analytical thinking prevalent in Western traditions – often characterized by breaking phenomena down into discrete components for detailed analysis – stands in opposition to the holistic thinking commonly observed in Chinese philosophy.

As a result, a scale designed based on dialectical thinking may not fully capture or even misinterpret the dialectical epistemology of Chinese students who tenant naïve dialecticism. For example, research[18] found that while dialectical thinking, as measured by the Dialectical Self Scale (DSS)[19], positively correlates with problem-solving skills among western students, such a relationship is slightly negative among Chinese samples. The DSS may have failed to tell the holistic cognitive patterns characteristic of naïve dialectical thinking which may distance Chinese students from analytical approaches[7].

Since epistemic beliefs overlap with dialecticism in their emphasis on the changing and interconnected nature of knowledge, existing EB scales may inherently overlook or even misinterpret Chinese students' responses. Items that assess epistemic beliefs may unintentionally capture elements of naïve dialecticism, which emphasizes holism rather than analytical thinking. As a result, Chinese students' responses may reflect a dialectical approach rather than a strictly analytical epistemic stance.

Therefore, it is essential to incorporate elements of naïve dialecticism into EB scales to more accurately assess the epistemic beliefs of Chinese students. Doing so would provide a more nuanced understanding of their perspectives and reduce potential misinterpretations in cross-cultural comparisons.

Methodology

A. Participants

As listed in Table 1, a total of 129 undergraduate and graduate students majoring in science education participated in this study for the EBAPS survey. The sample is categorized into two groups based on major and academic year: 1) **SE** Group comprises 86 junior students majoring in Science Education from a normal university in eastern China; and 2) **PE** group consists of 43 first year graduate students in the Physics Education program at the same university. All students invited in this research are enrolled in courses taught by two authors of this paper. The key distinction between the SE and PE groups is their educational focus: the SE group is oriented towards middle school science teaching, whereas the PE group is geared towards high school physics education.

Table 1. EBAPS survey participant demographics.

Group Code	Major	Academic year	Participants	Male	Female
SE	Science education	Junior	86	30	56
PE	Physics education	First-Year Graduate	43	26	17
Total			129	56	73

We invited 15 students to participate in post-survey interviews. Three of these students volunteered for pilot interviews, while the remaining twelve were selected based on their rankings in the total EBAPS survey scores, specifically those ranked 1, 11, 21, and so on. Minor adjustments were made during the selection process; for instance, when one participant declined the invitation, the next highest-ranked student was invited. The interviewees were then contacted in a random sequence.

To ensure diversity, the last three interviewees were not selected strictly according to the planned ranking scheme, as the initial twelve (including three pilots) had already been interviewed. Instead, the final three were carefully chosen based on their responses to specific survey questions significantly different from previous interviewees', although their overall survey ranks remained close to the initial scheme. These selection criteria were employed to obtain a small sample that better represents the diversity of students' survey responses. Table 2 lists demographic information of the interviewees.

Table 2. Interviewee demographics.

Group Code	Major	Academic year	Participants	Male	Female
SE	Science education	Junior	11	3	8
PE	Physics education	First-Year Graduate	4	2	2
Total			15	5	10

B. Survey Design

Developed by Elby et al., the Epistemological Beliefs Assessment for Physical Science (EBAPS) is a 30-item, forced-choice, Likert-type questionnaire designed to measure students' epistemic beliefs about the physical sciences. Each question is scored from 0 to 4, indicating the least to most sophisticated belief. The instrument is organized around five nonorthogonal axes: (1) Structure of Scientific Knowledge, (2) Nature of Knowing and Learning, (3) Real-Life Applicability, (4) Evolving Knowledge, and (5) Source of Ability to Learn. A detailed explanation of these axes is provided in Table 3. For more information on EBAPS, including scoring rubrics and administration guidelines, please visit its official websites[6], [20].

Table 3. Five non-orthogonal dimensions of EBAPS (adapted from the host website[20]).

1. *Structure of scientific knowledge*. Is physics and chemistry knowledge a bunch of weakly connected pieces without much structure and consisting mainly of facts and formulas? Or is it a coherent, conceptual, highly-structured, unified whole?
2. *Nature of knowing and learning.* Does learning science consist mainly of absorbing information? Or, does it rely crucially on constructing one's own understanding by working through the material actively, by relating new material to prior experiences, intuitions, and knowledge, and by reflecting upon and monitoring one's understanding?
3. *Real-life applicability.* Are scientific knowledge and scientific ways of thinking applicable only in restricted spheres, such as a classroom or laboratory? Or, does science apply more generally to real life? These items tease out students' views of the applicability of scientific knowledge *as distinct from* the student's own desire to apply science to real life, which depends on the student's interests, goals, and other non-epistemological factors.
4. *Evolving knowledge.* This dimension probes the extent to which students navigate between the twin perils of absolutism (thinking all scientific knowledge is set in stone) and extreme relativism (making no distinctions between evidence-based reasoning and mere opinion).

5. *Source of ability to learn.* Is being good at science mostly a matter of fixed natural ability? Or, can most people become better at learning (and doing) science? As much as possible, these items probe students' epistemological views about the efficacy of hard work and good study strategies, *as distinct from* their self-confidence and other beliefs about themselves.

Before administering the survey, one author translated it into Chinese. Two other authors, who had not seen the original EBAPS survey, then independently back-translated it into English. The resulting English versions were merged following discussions to ensure accuracy and consistency. Two colleagues, one fluent and one native in English, compared the merged back-translated version with the original survey to identify any semantic inconsistencies. Additionally, all translations were reviewed using ChatGPT 4o as a supplementary tool. When minor discrepancies were identified, the first author revised the Chinese translation and discussed the changes with the colleagues until all disagreements were resolved.

In addition to the original EBAPS items, four additional questions, shown in Table 4, were included to explore students' cognitive patterns under the influence of naïve dialecticism[17]. The first two items regarding attitudes toward contradictions were adapted from the Dialectical Self Scale[19], an instrument designed to measure dialectical thinking. The other two items were created by one of the authors to represent the remaining key components of naïve dialecticism: the "Principle of Relationship or Holism" (item iii) and the "Principle of Change"[17] (item iv). These four items are grouped under the category of "Naïve Dialecticism (ND)."

Table 4. Survey items introduced as the Naïve Dialecticism axis in this study.

i.	I sometimes believe two things that contradict each other.
ii.	Believing two things that contradict each other is illogical.
iii.	Clarifying the subtle differences between concepts is not very helpful in solving real-world problems.
iv.	There is no absolute truth, as things are constantly changing.

For item i), responses range from strongly disagree to strongly agree, scored 0 to 4. The remaining three items are reverse-coded, with strongly disagree corresponding to 4 and strongly agree corresponding to 0.

In the administered survey, these four questions appeared as Items 5, 11, 14, and 20, inserted directly after Items 4, 9, 11, and 16 of the original EBAPS, resulting in a 34-item instrument. However, for simplicity, the numbering of the original EBAPS items is maintained in this paper, and the four additional items are labeled as Item 31, 32, 33, and 34.

C. Interview Design

A semi-structured interview was designed to probe deeper into students' EB. For ethical concerns, the interviews were conducted by an author from a different university. The interview comprises two parts. In the first part, participants are asked to explain the reasons behind their choices on selected EBAPS survey items. These items are chosen according to three criteria:

i. The class average for the item is below 2.4/4.0.
ii. The participant's own score on the item is 2 or lower.
iii. Certain item pairs that were expected to correlate did not show any correlation in the survey results.

In the second part of the interview, we include three themes: (1) the nature of science and scientific knowledge, (2) content of learning abilities, and (3) contradiction and holistic thinking. Sample questions most relevant to this paper are list in Table 5. The first two themes were designed based on our hypothesis that a lack of proper knowledge about epistemology and learning abilities may contribute to students' low performance on the EBAPS survey. The third theme was included to better understand the reasons behind students' responses to the four additional questions incorporated into the EBAPS survey in this study and how these responses may influence students' epistemological beliefs.

Table 5. Themes and selected questions for the second part of the interview.

1. The Nature of Science and Scientific Knowledge
    a) Definition of knowledge
        - How do you define knowledge?
    b) Classification of knowledge
        - How do you categorize knowledge?
        - In science, we often talk about "laws" and "theories." What is the difference between these two concepts?
    c) Justification of knowledge
        - Broadly speaking, under what circumstances can you determine that a piece of knowledge in a book or said by an instructor is incorrect?
2. Content of Learning Abilities
    a) Learning abilities and effort
        - "A person can gain more knowledge through effort, but effort alone cannot improve their ability to learn." What do you think of this statement?
        - What do you think constitutes learning abilities?
    b) Memorizing and understanding
        - How is memorizing different from understanding?
3. Naïve Dialecticism and Analytical Thinking
    a) Contradiction
        - How do you deal with two explanations to a same phenomenon if they contradict each other?
    b) Holistic/analytical thinking
        - Some people think that identifying subtle differences between concepts is not very helpful for solving real-world problems. What is your opinion on this?
        - What does it mean to analyze? For example, analyzing a problem.

D. Data Analysis

The EBAPS survey was scored on a 0 – 4 scale in accordance with its guidelines and analyzed using IBM SPSS (version 25). For correlational analysis, we converted the 0 – 4 scores to 1 – 5 by adding 1 to each score. This adjustment was made because the original 0 – 4 scale does not represent strictly proportional quantities (i.e., a 0 does not imply no attitude); thus, shifting it to a 1 – 5 scale preserves students' relative responses while facilitating correlational analysis. Given the ordinal nature of the data, Spearman's rho was used to examine item correlations.

A factor analysis[21] is often used to examine the underlying structure of survey data, where survey questions that form a factor exhibit strong inter-item correlations, and such factors are relatively independent of one another. Gavin that a reliable and generalizable factor analysis typically requires a large sample size (N), a high sample-to-item (N/p) ratio, and/or high communalities[22], we did not employ factor analysis due to the small N and N/p in this study. Instead, we examine the inter-item correlations with our sample on survey items that constituted factors previously observed in American students[23]. This approach allowed us to gain preliminary insights into the structural difference in EB between Chinese and U.S. students.

The interviews were audio-recorded with the students' consent, and the audio files were transcribed into text by one author using the transcription function in Microsoft Word 365. To ensure accuracy, the author who conducted the interviews cross-checked the transcripts against the original audio files and resolved any discrepancies. Interviewees' personal information was removed, and a pseudonym was assigned to each transcription file before further analysis.

An inductive content analysis[24] was used to summarize major findings that are most relevant in answering the three research questions of this study. Two authors independently reviewed all interview transcripts to develop a comprehensive understanding of the textual data and identify student responses relevant to this study. They then categorized these responses and assessed their prevalence and frequency. Given the subjective nature of the data, any discrepancies were resolved through discussion between the two authors.

Results

A. Survey

Table 6 presents the mean scores and standard deviations for the EBAPS survey and the added dimension of naïve dialecticism (ND) for the SE and PE groups.

Table 6. EBAPS score per axis and naïve dialecticism (ND) for the SE (Science Education) and PE (Physics Education) groups

		Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Overall	ND
SE	Mean	2.60	2.90	3.14	2.18	2.25	2.62	2.56
(N = 86)	s.d.	0.38	0.34	0.59	0.77	0.58	0.28	0.49

PE (N = 43)	Mean s.d.	2.68 0.38	2.96 0.38	3.33 0.50	2.15 0.65	2.24 0.65	2.68 0.30	2.49 0.57

Overall, these students scored relatively high on Axis 3 ("Real-Life Applicability") and Axis 2 ("Nature of Knowing and Learning") but low on Axis 5 ("Source of Ability to Learn") and Axis 4 ("Evolving Knowledge").

When average scores on each factor – a group of items showing strong inter-item correlations – extracted in Ref [23] were computed (See Table 7), a distinct pattern of students' EB emerged. Chinese students scored relatively high on *Factor* 3 ("Source of Ability to Learn") compared to their low performance on *Axis* 5 ("Source of Ability to Learn").[2] Additionally, Chinese students scored notably low on Factor 2 ("Innate Ability vs Hard Work"), while their scores on the remaining three factors were comparable to the survey average. These factors include Factor 1: "Structure of Science," Factor 4: "Nature of Knowing and Learning," and Factor 5: "Quick Learning." For further details on these factors, please refer to Ref [23].

Table 7. Average scores on each factor in Ref [23] of the SE and PE groups.

		Factor 1*	Factor 2	Factor 3	Factor 4	Factor 5
SE (N = 86)	Mean s.d.	2.59 0.50	1.56 0.78	3.15 0.45	2.73 0.84	2.54 0.85
PE (N = 43)	Mean s.d.	2.68 0.66	1.74 0.93	3.01 0.50	3.00 0.81	2.43 0.84

*Factor 1 consists of item 6, 8, 10, and 14 in the EBAPS survey; Factor 2: item 21, 22, and 25; Factor 3: items 5, 11, 12, and 16; Factor 4: 28 and 30; Factor 5: items 4 and 9.

Although the SE and PE groups exhibit similar average scores, the Box's test of equality of covariance matrices yielded a significant result ($p = 0.004$), indicating that the two datasets are not homogeneous. As a result, correlational analyses were conducted separately for the SE and PE groups. Table 8 lists the correlations of item pairs within each factor for the SE group. Full correlation results for group SE and PE can be found in Appendix.

Table 8. Spearman's rho correlations of item pairs within each factor for group SE in this study.

	Factor 1						Factor 2		
Item pair	6/8	6/10	6/14	8/10	8/14	10/14	21/22	21/25	22/25
Rho Sig.	0.040 0.718	-0.196 0.070	0.056 0.610	-0.016 0.883	0.068 0.535	-0.090 0.410	0.408 0.000	0.220 0.041	0.502 0.000
	Factor 3						Factor 4	Factor 5	
Item pair	5/11	5/12	5/16	11/12	11/16	12/16	28/30	4/9	
Rho Sig.	0.304 0.004	0.220 0.041	0.241 0.026	0.232 0.031	0.068 0.536	0.127 0.242	0.114 0.297	0.327 0.002	

2 By design, the EBAPS does not necessarily ensure stronger inter-item correlations within an axis. Therefore, items within an axis may not form a distinct factor.

B. Interview

In this section, we report key findings from semi-structured interviews with the fifteen students. We organize the results around the study's first two research questions to help readers see how the interview data directly addresses each question. Within each research-question-based subsection, we highlight the recurring themes or patterns that emerged, supported by illustrative quotes from participants.

RQ1: What are the epistemic beliefs of Chinese university students?

Views on the Nature of Knowledge

Across the interviews, students often described knowledge as either (i) information found in textbooks and life experiences or (ii) summaries or explanations of how the world works. Only four students out of fifteen implicitly referenced the idea that knowledge is justified information. While a majority agreed that "knowledge can change over time," four students felt that, for the most part, knowledge is fixed – emphasizing that although some theories may evolve, most content remains stable within a typical lifespan.

When asked to distinguish laws from theories, many students viewed laws as solid, universally true statements and theories as opinions, speculations, hypotheses, or predictions rather than rigorously validated explanations.

Beliefs About Learning Abilities

Over half the participants maintained that learning abilities are largely innate and resistant to change. Some students defended this view by citing personal stories (e.g., "*I used to sleep in science class but still got great grades.*"),[3] while others mentioned classroom observations during their teaching practicum (e.g., "*Some students immediately get it, but some don't, no matter what*."). Only six students believed that learning abilities can be improved through repeated practice and better strategies: "*If someone is learning a method of learning, then their hard work and effort will improve their learning ability*." Notably, few interviewees explicitly referenced formal ideas from learning science – such as metacognition, growth mindset, or Bloom's Taxonomy – to support their viewpoints.

Memorizing Versus Understanding

Nearly all participants could articulate a distinction between memorizing ("*just storing knowledge*") and understanding ("*being able to explain or apply what one learned*"). A few students linked the process of learning to "*levels*" or "*hierarchies*," although they did not explicitly name Bloom's Taxonomy. For instance, one noted that memorization often precedes deeper understanding, which in turn leads to more robust application and finally innovation.

RQ2: What Factors Might Contribute to the Epistemic Belief Differences of Chinese Students?

3 Quotes from samples of this study are in italics.

Authority-Centered Education and Limited Epistemology Training
When asked how they decide whether an instructor or textbook might be wrong, nine students deferred to external authority ("*A college textbook must be more accurate than a high school one*"). Eight students identified logical reasoning as a method to justify knowledge. Only one student suggested the need to evaluate the reliability of the research process, object, and conclusion that support a given statement. This emphasis on hierarchical authority may stem from an exam-driven education system, in which students have fewer explicit opportunities to learn about the nature of science or about learning theory, even for the science education majors.

Naïve Dialecticism
The first principle constitutes naïve dialecticism is the "Principle of Change", which posits that "reality is a process" and so are the concepts reflect it. Of the ten students asked to explain their reasoning behind their responses to survey Item 34 ("There is no absolute truth, as things are constantly changing"), four students agreed that there is no absolute truth, aligning with this principle. Meanwhile, five students affirmed the existence of absolute truth, and one expressed skepticism about the concept of absolute truth.

The second principle of naïve dialecticism is the "Principle of Contradiction", which suggests that reality is inherently imprecise and filled with contradictions due to its constantly changing nature. When asked about their attitude toward contradictions, six out of fifteen students expressed that they could accept both sides of a contradiction – either because they viewed the two sides as inseparable or because they were not able to determine which side was more valid. Others, however, aligned more with the principle of noncontradiction and resolved inconsistencies by picking one "*correct*" viewpoint. Notably, when students who tolerated contradictory arguments were asked to provide examples, some referenced the wave-particle duality in physics, while others pointed to value-based contradictions (e.g., "*I like my brother and hate him at the same time*") rather than factual ones.

The third principle of naïve dialecticism is the "Principle of Holism", which suggests that due to the first two principles, analytical thinking may not always be seen as a practical approach to understanding the world. This principle is evident in the responses of four out of fourteen students, who stated that differentiating concepts has little practical value in real-life situations, though they acknowledged its usefulness for exams. Meanwhile, eight students disagreed with the statement that "Clarifying the subtle differences between concepts is not very helpful in solving real-world problems" (Item 33), while two students offered more situational and contextual perspectives.

When asked to define the task of analyzing, ten out of fifteen students described it as a structured, stepwise method for problem-solving or learning new material (e.g., asking "what," "why," and "how" questions to gain a deeper understanding). Two students did not provide substantive answers. Without explicitly referencing its name, three students gave definitions closely aligned with Bloom's Taxonomy (e.g., "*collecting information and identifying useful pieces through reasoning*").

Discussion

In this section, we address three interconnected themes. First, we revisit the well-documented phenomenon that Chinese students appear to show limited views of "Evolving Knowledge" and "Source of Ability to Learn" – yet our factor-level analysis reveals a more nuanced picture. Specifically, although they perform poorly on the factor "Innate Ability vs Hard Work," they simultaneously excel in the factor "Source of Ability to Learn," suggesting that the original EBAPS axis may blur these two dimensions in a way that underestimates Chinese students' true beliefs about improving learning. Second, we explore deeper structural differences underlying their epistemic beliefs, highlighting how exam-oriented training, a culturally rooted distinction between "laws" and "theories", and naïve dialecticism might result in Chinese students' unique EB structure. Finally, we propose specific revisions to both the EBAPS survey and instructional approaches to better account for cultural factors that have shaped Chinese students' EB and influenced their learning processes.

A. Chinese students score low on "Evolving Knowledge" and "Innate Ability vs Hard Work" but high on "Source of Ability to Learn".

To better illustrate EB differences between Chinese and U.S. students, we compared our results to data from two American samples that completed the same EBAPS survey.

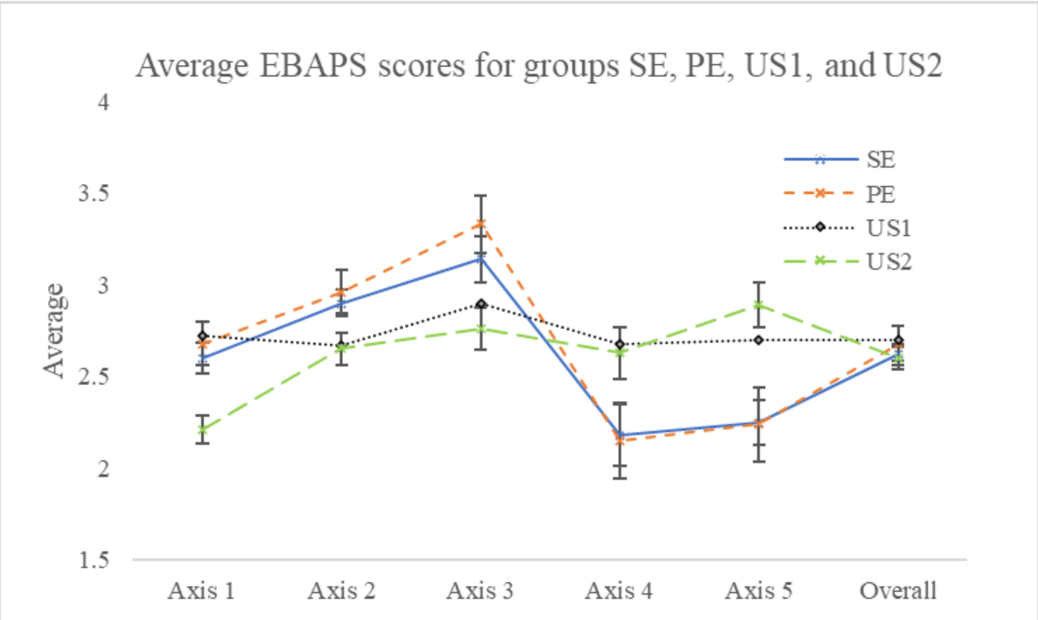

Figure 1. EBAPS scores with 95% confidence intervals. SE and PE represent Chinese students from this study, while US1 and US2 refer to samples from Ref [25] and [26], respectively.

Sample US1 consists of 55 high school students from "a large magnet high school for gifted and talented students" in Virginia who were enrolled in a physics course[25][4]. Sample US2 is drawn from a "medium-sized, midwestern, land grant institution with an open enrollment

4 Their reported EBAPS scores, originally scaled to 100%, were converted to the 0 – 4 scale used in this research.

policy"[26][5]. Ref [26] shares the same student sample and EBAPS data with Ref [23].

Low on Evolving Knowledge
This study confirms previous findings that Chinese students are more likely to view knowledge as fixed than their American counterparts do[4], [5], as indicated by the significantly lower score on Axis 4 ("Evolving Knowledge") shown in Figure 1.

Interview data from this study reveals a specific reason for this perception: Chinese students tend to equate scientific knowledge primarily with scientific laws (or even mistakenly with mathematical principles), which change far less frequently than other aspects of scientific knowledge, such as hypotheses and theories. Additionally, their interpretation of theory differs from the scientific definition. Rather than understanding theories as validated ideas based on evidence and logical reasoning, most students in this study interpret theory as opinions, speculations, hypotheses, or predictions. This misconception contributes to their more static view of scientific knowledge.

Low on "Innate Ability vs Hard Work" but High on "Source of Ability to Learn"
Regarding learning abilities, we found that Axis 5 "Source of Ability to Learn" in the original EBAPS may be misleading in assessing Chinese students' beliefs about learning abilities. Axis 5, which includes Items 5, 9, 16, 22, and 25 (Table 9), appears to encompass elements of three distinct epistemic belief dimensions: *a*) belief in the improvability of learning abilities (Items 5 and 16 from Factor 3 "Source of Ability to Learn"); *b*) belief in whether scientific knowledge is quickly learned or not at all (Item 9 from Factor 5 "Quick Learning"); and *c*) belief in whether scientific achievement is attributed to hard work or innate ability (Items 22 and 25 from Factor 2 "Innate Ability vs. Hard Work").

As a result, Chinese students' low performance on Axis 5 is primarily driven by their low scores on Factor 2, "Innate Ability vs. Hard Work" (mean = 1.56, SE group in Table 7), rather than by Factor 3 (mean = 3.15) or Factor 5 (mean = 2.54). Therefore, it is more accurate to conclude that Chinese students are more likely to believe that scientific success heavily depends on innate abilities, rather than stating that they do not believe learning abilities are improvable. Interview data supports this conclusion, as students often expressed a balanced perspective, acknowledging that learning ability consists of both innate and malleable components.

A lack of understanding of learning science may have contributed to Chinese students' belief in the innate nature of learning abilities. Instead of relying on scientifically proven knowledge about learning and cognition, they tend to base their conclusions on personal learning experiences and observations. For example, many students are generally unaware of the finer cognitive skills outlined in Bloom's Taxonomy or theories emphasizing the malleability of learning abilities, such as the growth mindset[27]. Compounded with limited exposure to the process of scientific inquiry, students tend to attribute scientific success to innate abilities

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5 Within this dataset, we specifically selected the 113 Education/Health & Human Development students – labeled ED in Table IV – because their academic backgrounds align more closely with those of the participants in our study.

rather than to a set of frameworks and strategies that can be learned and improved.

Table 9. The five items of Axis 5 “Source of Ability to Learn” in the EBAPS survey.

Item 5. If someone is having trouble in physics or chemistry class, studying in a better way can make a big difference.

Item 9. Someone who doesn’t have high natural ability can still learn the material well even in a hard chemistry or physics class.

Item 16. Given enough time, almost everybody could learn to think more scientifically, if they really wanted to.

Item 22. To be successful at science...

(a) Hard work is much more important than inborn natural ability.
(b) Hard work is a little more important than natural ability.
(c) Natural ability and hard work are equally important.
(d) Natural ability is a little more important than hard work.
(e) Natural ability is much more important than hard work.

Item 25. Anna: I just read about Kay Kinoshita, the physicist. She sounds naturally brilliant.

Emily: Maybe she is. But when it comes to being good at science, hard work is more important than “natural ability.” I bet Dr. Kinoshita does well because she has worked really hard.

Anna: Well, maybe she did. But let’s face it, some people are just smarter at science than other people. Without natural ability, hard work won’t get you anywhere in science!

(a) I agree almost entirely with Anna.
(b) Although I agree more with Anna, I think Emily makes some good points.
(c) I agree (or disagree) equally with Anna and Emily.
(d) Although I agree more with Emily, I think Anna makes some good points.
(e) I agree almost entirely with Emily.

Students’ high scores on Factor 3, “Source of Ability to Learn,” can be attributed to their extensive exam-oriented training, as the items in this factor specifically target learning processes. As suggested by previous studies[4], [5], exam-oriented education does not necessarily promote rote memorization alone. Strategies for deep understanding and complex problem-solving are also valued, at least in the context of achieving high exam scores. Therefore, when questions are framed in a way that implicitly or explicitly relates to passing exams, Chinese students tend to strongly believe that hard work and proper training lead to success.

B. Differences in the inner structure of Chinese versus U.S. students’ EBs may be explained by misconceptions of NOS and naïve dialecticism typical to Chinese students.

While similar EB structures are shared by Chinese and U.S. students on Factors 2, 3, and 5, as indicated by significant inter-item correlations within each factor in the Chinese sample, the two student groups exhibit different patterns in Factor 1 (“Structure of Science”) and Factor 4 (“Nature of Knowing and Learning”). This section explores two key cultural elements – limited knowledge of the nature of science (NOS) and naïve dialecticism – that help explain why Chinese students exhibit weaker correlations between items that form Factor 1 and Factor 4 in American samples.

1. Limited Knowledge of the Nature of Science

We suggest that a lack of knowledge and misconceptions about the NOS of Chinese students are key reasons for the absence of strong inter-item correlations within Factor 1 (Table 10) and for items containing keywords such as "science", "scientist", and "theory".

Both Axis 1 in the EBAPS and Factor 1 in Ref [23] describe the interconnected nature of scientific knowledge which is coherent and highly-structured. Specifically, students in Ref [23] express that "theories act as a webbing which connects and accounts for information". Their written responses often incorporate "philosophical, psychological, and occasionally sociological aspects" of the NOS, including statements such as "science is an attempt to explain phenomena," "scientists work collaboratively," "science aims to be consistent," and "science relies on skepticism." Students' knowledge and beliefs about the NOS are thus suggested as the overarching theme contributing to the high inter-item correlations among the items constituting Factor 1.

Table 10. EBAPS items that constitutes Factor 1 in Ref [23].

Item 6. When it comes to controversial topics such as which foods cause cancer, there's no way for scientists to evaluate which scientific studies are the best. Everything's up in the air!
Item 8. Scientists should spend almost all their time gathering information. Worrying about theories can't really help us understand anything.
Item 10. Often, a scientific principle or theory just doesn't make sense. In those cases, you have to accept it and move on, because not everything in science is supposed to make sense.
Item 14. Understanding science is really important for people who design rockets, but not important for politicians.

In contrast, interview data reveal that most students in this study interpret theory as opinions, speculations, hypotheses, or predictions rather than as well-substantiated explanations. Additionally, they tend to perceive scientific knowledge primarily as laws or even mathematical principles, rather than as a dynamic and evolving body of knowledge. Consequently, they may interpret survey items containing the terms "science," "scientist," and "theory" differently from U.S. students.

Take items 6 and 10, for example, which show a slight negative correlation in the Chinese sample. In the U.S. sample[23], students who *disagree* with the statement "There is no way for scientists to evaluate which scientific studies are the best" (Item 6) also tend to *disagree* with the statement "Not everything in science is supposed to make sense" (Item 10). This alignment reflects a conclusive belief that while scientific results may appear contradictory or confusing, such discrepancies can and should ultimately be resolved through reasoning and evidence. In the Chinese sample, however, students who *agree* with Item 6, interpreting ongoing scientific studies as merely subjective opinions of scientists, may be more likely to *disagree* with Item 10 where they equate science primarily with solid and universally valid laws.

For the same reason, Item 28 does not correlate with Item 30 in Factor 4 and Item 16 shows much weaker correlations with the other items within Factor 3. Both Item 28 and Item 16 require conceptual understandings of science. Given the previously noted misconceptions about these concepts among Chinese students, their understanding of and responses to these items may significantly differ from their U.S. counterparts and show different structures.

2. Naïve Dialecticism

In addition to gaps in NOS knowledge, we suggest that Chinese students' tendency toward naïve dialecticism is another key factor contributing to the differences in their EB structure. We first illustrate how naïve dialecticism manifests in survey and interview results, followed by a discussion of its influence on students' responses to related items in the EBAPS survey.

The presence of naïve dialecticism

We preliminarily confirm the tendency toward naïve dialecticism among students through additional survey questions (Items 31–34) and related interview responses.

The influence of the Principle of Change is evident in students' "neutral" to "somewhat agree" stance toward Item 34, "There is no absolute truth, as things are constantly changing" (mean = 1.42, SE group). Students' strong inclination to agree with this statement may have prevented them from engaging in a logical examination of its inherent contradiction - that if *everything is constantly changing*, then the changing nature of things itself must be an absolute truth. Among the four students interviewed who agreed that there is no absolute truth, two were able to recognize the self-contradiction within the statement upon a second thought, while the other two did not and continued to assert that absolute truth does not exist.

The Principle of Contradiction manifests in students' survey responses, as reflected by their average stance of "somewhat agree" on Item 31, "I sometimes believe two things that contradict each other" (mean = 3.03, SE group), and "somewhat disagree" on Item 32, "Believing two things that contradict each other is illogical" (mean = 2.92, SE group). To many students interviewed, contradiction is perceived more as a way to describe the coexistence of two facets of reality rather than as two opposing statements that cannot logically be true simultaneously. This perspective aligns with naïve dialecticism, which tends to accommodate contradictions rather than seek to resolve them.

While students, on average, hold a "somewhat disagree" stance toward Item 33, "Clarifying the subtle differences between concepts is not very helpful in solving real-world problems" (mean = 2.87, SE group), the Principle of Holism is still evident in some students. Four out of fourteen interviewed students expressed the belief that differentiating concepts has little practical value in solving real-life problems and is only useful for passing exams. When asked to define the action of analyzing, only three out of fifteen students provided a definition close to "*breaking things down into smaller pieces*." The majority, however, equated analyzing with following a set procedure for a specific type of task, suggesting a more procedural rather than analytical approach to problem-solving. This perspective aligns with the holistic thinking tendency, where conceptual analysis is often de-emphasized in favor of practical procedures, based on the belief that viewing anything in isolation leads to a distorted understanding, as individual parts gain meaning only through their connection to the whole.

The influence of naïve dialecticism on EBAPS performance
One significant influence of naïve dialecticism on students' responses is their resistance to statements that appear too absolute or extreme, as such statements violate the Principle of Change and the Principle of Contradiction. This tendency may contribute to the lack of inter-item correlation within Factor 1.

For example, in Item 6, while students may acknowledge that evaluating a study is difficult, they may still choose to disagree simply because "*Saying everything is up in the air feels too absolute to me*." Similarly, students' disagreement with Item 8 may not stem from an understanding of the complexity of scientific research, but rather from their discomfort with the absolute phrasing – terms like "spending almost **all** their time" and "can't…understanding **anything**" may feel too extreme. Additionally, multiple students explicitly mentioned that they avoid selecting "strongly agree" or "strongly disagree" simply because such responses feel too absolute.

Students' avoidance of absolute statements is further reflected in the slight negative correlation between Item 6 and Item 10 (rho = -0.196, p = 0.070). Item 10 is phrased in a more moderate tone. As a result, students who disagree with "Everything's up in the air" (scoring high on Item 6) may be more likely to agree with "Not everything in science is supposed to make sense" (scoring low on Item 10).

Another significant influence of naïve dialecticism, specifically the Principle of Holism, may explain the lack of correlation between Item 28 and Item 30 in Factor 4. While U.S. students may perceive both items as reflecting the same underlying principle – the need to justify and evaluate knowledge analytically in both learning and science discovering – Chinese respondents may interpret them differently. For Chinese students in an exam context, extra effort pays off, as it helps them get closer to the standard answers. However, outside of exams, an analytical approach may feel futile, as contradictions are perceived as naturally coexisting, and greater value is placed on seeking practical stances or solutions rather than resolving contradictions.

In addition, the influence of Holism may also explain the sharp contrast between Chinese students' low scores on "Evolving Knowledge" and high scores on "Real-Life Applicability" (Axis 4 and Axis 3 in Figure 1). While they tend to overlook analytical effort in scientific discovery – leading to a more fixed view of scientific knowledge – they are highly confident that such knowledge, already more complex than simple *yin-yang* interconversion, is sufficient for daily practical applications.

C. Implications for Teaching and Potential Revision of the EBAPS for Chinese Students

Given these findings, we point to several actionable directions for improving both the teaching of science to Chinese students and the measurement of their EB. Below, we discuss how explicitly teaching the NOS and learning theory may benefit Chinese students, why certain revisions to the EBAPS could yield a more accurate cultural fit, and how attending to students' analytical skills might help reveal their stance on the evolving, interconnected nature of scientific knowledge.

1. Explicitly Teaching NOS and Learning Science

Many Chinese students in our sample associated "scientific knowledge" mostly with fixed "laws" or even abstract mathematical principles rather than with an evolving body of work that emerges from testing, revising, and justifying ideas. Given their exam-oriented background, students often lack explicit instruction on how theories are developed, challenged, and refined through evidence-based reasoning. Practical steps include adding short modules on how scientists historically changed their views (e.g., the shift from geocentrism to heliocentrism), emphasizing the processes of peer review and scientific debate, and relating major scientific discoveries to how evidence accumulates or shifts interpretations over time. As suggested by research[13], [26], [28], teaching of NOS may enhance Chinese students' epistemic beliefs as well.

While our participants were science education majors, many lacked exposures to formal learning theories or models of cognitive development. For example, only a few students referenced concepts akin to metacognition or Bloom's Taxonomy, which emphasize how higher-level cognitive skills (analysis, evaluation, and creation) can be taught and developed. Integrating these ideas into education – whether through standalone courses or modules embedded in existing pedagogy classes – can help Chinese students see that abilities they perceive as innate can be fostered through targeted strategies, deliberate practice, and appropriate scaffolding[28].

2. Revising EBAPS to Avoid Extreme or Absolute Wording

One distinctive finding was that many Chinese students hesitated to strongly agree or disagree with statements framed in absolute terms. This tendency aligns with naïve dialecticism, which emphasizes the coexistence of contradictory ideas and devalues statements that appear too black-and-white.

For instance, items with wording such as "there's no way," "everything," or "always" tended to elicit moderate or even contradictory responses, less because of students' epistemic stance and more because of their cultural discomfort with absolute language. Sweeping absolutes ("nothing," "everything," "always," "completely") may be replaced with more measured language ("some," "many," "often," "can be," "might be") to avoid forcing participants into such a binary extreme. For instance, rather than "*Everything*'s up in the air", a rephrasing might be, "Many things are up in the air". Such refinements help ensure that students' disagreements or agreements are driven by genuine epistemic beliefs rather than by the phrasing of the item itself.

3. Assessing Analytical Skills to Reveal Beliefs About Evolving and Interconnected Knowledge

Chinese students' views of knowledge as "interconnected" is partially rooted in holistic thinking. This can mask or even distort how they respond to items about the "evolving" and "interconnected" nature of scientific knowledge. Students may readily endorse the interconnectedness of concepts – yet resist performing the stepwise, analytical justifications that reveal how knowledge changes or why it should be challenged.

A productive next step in measuring epistemic beliefs may be to include brief tasks or scenarios that examine students' analytical aptitude and skills. In this way, researchers and instructors can better disentangle whether students' stated acceptance of contradictions stems from naïve dialecticism or from a genuine belief in the evidence-based, ever-evolving nature of science.

Conclusion and Next Steps

This study underscores how Chinese students' epistemic beliefs are shaped by three major challenges: limited exposure to the nature of science (NOS), a lack of grounding in learning sciences, and the influence of naïve dialectics. They tend to view scientific knowledge primarily as fixed laws rather than as an evolving body of ideas. While they believe hard work can enhance exam performance, they often see success in science as heavily reliant on innate ability. Furthermore, the moderate and nonanalytical stance influenced by naïve dialectics may have obscured their understanding of the evolving, interconnected nature of knowledge.

The findings are constrained by several limitations: the relatively small sample size from one region, the reliance on self-reported survey data, and a cross-sectional design that cannot fully capture belief development over time. Future studies could include more diverse Chinese student populations, employ longitudinal methods to track changes in students' beliefs, and incorporate revised EBAPS items that avoid absolute expressions and probe students' analytical reasoning. Such work would deepen our understanding of epistemic beliefs in various cultural contexts and inform more tailored, inclusive instructional strategies.

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Appendix

Spearman's rho between all 34 survey items of the science education (SE) group (N = 86) and the physics education (PE) group (N = 43). Data for the PE group are highlighted. Items 1-30 are from the EBAPS survey, while items 31–34 represent the naïve dialecticism dimension introduced in this study.

Item	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	-0.293	-0.056	0.005	0.048	-0.038	0.288	.413**	0.181	0.132	-0.112	0.113
		0.057	0.723	0.974	0.762	0.810	0.061	0.006	0.247	0.398	0.473	0.472
2	-.254* (Correlation Coefficient)	1.000	0.083	0.063	0.003	-0.058	-0.085	-0.232	-0.068	-0.002	-0.155	0.044
	0.018 (Sig. (2-tailed))		0.598	0.687	0.987	0.712	0.590	0.135	0.666	0.990	0.320	0.778
3	-.227*	.216*	1.000	0.099	0.001	0.250	0.161	0.021	-0.062	0.055	-0.036	0.109
	0.036	0.046		0.526	0.996	0.106	0.303	0.893	0.694	0.726	0.821	0.487
4	0.177	-0.203	-0.052	1.000	0.082	0.253	0.264	0.269	0.220	0.271	-0.073	0.032
	0.103	0.061	0.635		0.600	0.102	0.087	0.082	0.156	0.079	0.643	0.841
5	0.065	-0.169	0.082	0.188	1.000	0.067	0.098	0.033	-0.071	-0.075	-0.022	0.038
	0.551	0.119	0.453	0.083		0.669	0.533	0.834	0.649	0.633	0.890	0.810
6	0.178	-0.094	0.010	0.047	0.066	1.000	0.269	0.190	-0.228	-0.077	-.431**	-0.012
	0.100	0.389	0.927	0.666	0.545		0.081	0.222	0.141	0.623	0.004	0.937
7	0.144	-0.040	-0.149	.303**	0.012	0.100	1.000	.407**	0.198	0.250	-0.181	0.104
	0.187	0.715	0.172	0.005	0.911	0.359		0.007	0.202	0.106	0.245	0.507
8	0.178	-0.207	0.180	.281**	.387**	0.040	.254*	1.000	0.083	0.234	-0.147	0.122
	0.102	0.056	0.098	0.009	0.000	0.718	0.018		0.599	0.131	0.346	0.434
9	0.099	-0.023	-0.060	.327**	.332**	0.165	.242*	.262*	1.000	0.246	0.248	0.092
	0.364	0.831	0.581	0.002	0.002	0.129	0.025	0.015		0.112	0.109	0.557
10	-0.126	0.027	-0.135	-0.013	0.026	-0.196	0.004	-0.016	-0.036	1.000	0.267	0.023
	0.248	0.808	0.214	0.905	0.816	0.070	0.968	0.883	0.742		0.084	0.881
11	-0.036	0.035	0.057	-0.007	.304**	-0.134	-0.013	0.204	0.089	0.012	1.000	0.001
	0.743	0.746	0.603	0.949	0.004	0.219	0.909	0.060	0.413	0.915		0.997
12	0.135	0.023	0.055	0.176	.220*	0.083	0.113	0.145	.255*	0.074	.232*	1.000
	0.217	0.832	0.617	0.106	0.041	0.448	0.299	0.181	0.018	0.497	0.031	
13	-0.026	0.196	0.031	-0.130	-0.177	-.247*	-0.010	-0.014	-.244*	0.025	-.263*	-0.178
	0.809	0.070	0.776	0.233	0.103	0.022	0.930	0.899	0.023	0.819	0.014	0.100
14	0.049	-0.158	0.011	.351**	0.029	0.056	.230*	0.068	.320**	-0.090	0.042	0.187
	0.653	0.145	0.923	0.001	0.791	0.610	0.033	0.535	0.003	0.410	0.701	0.085
15	0.196	-.371**	-0.152	.343**	0.067	0.163	0.193	0.100	.242*	-0.167	-0.024	-0.143
	0.070	0.000	0.163	0.001	0.538	0.135	0.075	0.361	0.025	0.124	0.827	0.189
16	0.156	0.075	0.176	.262*	.241*	0.057	-0.039	0.155	0.197	-0.152	0.068	0.127
	0.153	0.493	0.104	0.015	0.026	0.603	0.723	0.154	0.068	0.162	0.536	0.242
17	.224*	-0.195	-0.052	.359**	0.193	0.165	.239*	0.191	.297**	0.066	-0.015	0.126
	0.038	0.072	0.636	0.001	0.075	0.128	0.026	0.078	0.005	0.543	0.890	0.246
18	0.056	-.262*	0.190	0.087	0.069	0.112	-0.104	0.178	0.018	-0.176	-0.104	-0.001
	0.611	0.015	0.080	0.427	0.528	0.306	0.342	0.101	0.867	0.106	0.339	0.996

Item	1	2	3	4	5	6	7	8	9	10	11	12
19	-0.118	0.024	-0.049	0.193	0.144	-0.057	.243*	0.181	0.045	0.132	0.118	0.005
	0.281	0.824	0.652	0.074	0.186	0.602	0.024	0.095	0.677	0.225	0.278	0.962
20	0.201	-0.033	-.221*	-0.073	-0.030	0.093	0.115	-0.070	0.005	0.076	-0.015	-0.079
	0.064	0.763	0.040	0.504	0.787	0.393	0.292	0.523	0.963	0.486	0.893	0.467
21	0.009	0.051	-0.193	0.052	0.080	-0.028	0.072	0.141	.339**	0.061	0.128	0.127
	0.934	0.641	0.076	0.636	0.462	0.797	0.509	0.195	0.001	0.579	0.242	0.243
22	0.087	0.159	0.034	0.166	.219*	0.046	0.105	.309**	.265*	0.044	0.132	0.109
	0.427	0.145	0.759	0.127	0.042	0.674	0.334	0.004	0.014	0.688	0.226	0.318
23	0.106	-0.068	-0.105	-0.002	-0.127	0.075	.324**	-0.133	-0.096	-0.090	0.101	0.139
	0.333	0.537	0.336	0.987	0.245	0.491	0.002	0.221	0.377	0.409	0.355	0.202
24	-0.021	0.154	0.067	0.105	-0.114	-0.203	0.101	0.144	0.020	-0.093	0.084	-0.031
	0.851	0.157	0.537	0.337	0.294	0.060	0.355	0.185	0.853	0.392	0.442	0.776
25	.241*	-0.072	-0.041	0.149	0.183	0.189	0.080	.271*	.288**	-0.193	0.081	0.116
	0.026	0.509	0.705	0.170	0.092	0.081	0.462	0.012	0.007	0.076	0.456	0.288
26	0.007	-0.075	-0.071	-0.042	-0.086	-0.101	-0.015	0.005	0.047	.258*	-0.109	0.015
	0.950	0.494	0.515	0.702	0.429	0.353	0.889	0.963	0.669	0.016	0.316	0.892
27	0.051	0.109	0.117	-0.045	0.065	-0.063	0.060	0.206	-0.010	-0.025	0.193	0.012
	0.638	0.320	0.284	0.681	0.552	0.566	0.584	0.057	0.930	0.817	0.076	0.911
28	0.086	-0.093	-.241*	-0.052	-0.052	-0.043	0.093	-0.086	0.156	-0.118	-0.014	0.075
	0.433	0.396	0.025	0.636	0.635	0.691	0.394	0.430	0.151	0.279	0.901	0.495
29	-0.088	0.055	0.023	-0.048	0.139	-0.013	0.165	0.066	0.145	-0.025	0.067	-0.016
	0.423	0.612	0.835	0.658	0.203	0.908	0.128	0.548	0.182	0.822	0.539	0.882
30	.246*	-0.204	-0.200	.278**	-0.056	0.038	0.178	0.033	0.199	-0.113	0.111	0.128
	0.022	0.059	0.065	0.010	0.606	0.727	0.100	0.764	0.066	0.300	0.307	0.241
31	-0.084	0.042	0.159	-0.047	0.134	-0.019	-0.143	0.091	0.089	-.223*	0.106	0.097
	0.441	0.699	0.144	0.667	0.218	0.864	0.188	0.405	0.417	0.039	0.330	0.375
32	-0.095	0.056	-0.066	-0.050	-0.052	0.007	0.204	0.093	-0.028	-0.135	-0.098	0.020
	0.384	0.609	0.546	0.649	0.632	0.952	0.059	0.395	0.796	0.216	0.371	0.852
33	.246*	-0.148	-0.001	.244*	.244*	.268*	.237*	.234*	.309**	-0.181	.261*	0.149
	0.022	0.173	0.995	0.024	0.024	0.012	0.028	0.030	0.004	0.096	0.015	0.172
34	.221*	-0.119	-.215*	-0.011	0.019	.228*	0.104	-0.034	0.164	0.147	-0.196	.269*
	0.041	0.275	0.047	0.923	0.864	0.035	0.342	0.755	0.132	0.178	0.071	0.012

Item	13	14	15	16	17	18	19	20	21	22	23	24
1	-0.014	0.280	0.113	-0.002	0.087	0.011	0.083	-0.110	0.204	0.016	0.209	0.237
	0.928	0.069	0.472	0.988	0.578	0.946	0.595	0.481	0.189	0.920	0.179	0.126
2	-0.239	-0.263	0.016	0.097	0.027	0.152	0.002	-0.205	-0.042	-0.205	-0.117	-0.026
	0.122	0.088	0.917	0.537	0.862	0.330	0.991	0.188	0.789	0.187	0.454	0.868
3	-0.233	-0.141	-0.013	0.208	0.217	-0.108	0.153	-0.210	0.079	0.098	-0.291	-0.170
	0.133	0.366	0.936	0.182	0.162	0.490	0.328	0.177	0.613	0.530	0.058	0.275
4	-0.045	0.044	0.269	0.082	0.032	-0.109	0.033	0.177	0.250	0.282	-0.131	0.050
	0.775	0.781	0.081	0.601	0.837	0.488	0.832	0.256	0.106	0.067	0.403	0.749
5	0.191	0.067	0.182	0.138	-0.010	0.099	-0.155	0.256	0.040	0.254	0.146	0.138
	0.219	0.670	0.242	0.377	0.948	0.527	0.320	0.098	0.798	0.101	0.350	0.376
6	-0.096	0.140	-0.003	-0.210	0.265	-0.105	.356*	0.169	0.272	0.016	-0.052	-0.037
	0.541	0.371	0.984	0.175	0.086	0.501	0.019	0.280	0.077	0.917	0.738	0.816

Item	13	14	15	16	17	18	19	20	21	22	23	24
7	.518**	-0.034	0.044	0.156	.424**	-0.031	0.086	0.126	.331*	0.239	0.137	0.185
	0.000	0.828	0.778	0.318	0.005	0.844	0.584	0.420	0.030	0.123	0.379	0.235
8	0.251	-0.132	0.139	0.082	0.061	0.272	0.260	-0.027	0.015	-0.009	0.000	0.116
	0.105	0.399	0.374	0.599	0.697	0.077	0.093	0.864	0.922	0.954	1.000	0.458
9	0.154	0.228	0.089	-0.065	0.158	-0.081	0.025	0.071	-0.150	0.265	0.143	-0.062
	0.324	0.141	0.571	0.679	0.312	0.604	0.871	0.649	0.337	0.086	0.360	0.693
10	0.059	-0.101	0.089	0.091	-0.008	-0.110	0.028	.333*	-0.065	-0.075	0.101	0.045
	0.708	0.519	0.569	0.561	0.958	0.484	0.858	0.029	0.677	0.634	0.520	0.775
11	-0.011	0.088	0.021	-0.244	-0.176	-.332*	-0.131	.321*	-0.279	-0.005	0.226	0.004
	0.943	0.573	0.895	0.115	0.259	0.029	0.402	0.036	0.070	0.973	0.146	0.978
12	-0.222	0.162	0.073	-0.085	0.070	-0.235	-0.173	-.339*	0.210	-0.186	-.339*	0.067
	0.152	0.299	0.643	0.588	0.655	0.129	0.267	0.026	0.177	0.233	0.026	0.668
13	-0.186	0.138	-0.147	-0.274	0.004	.375*	-0.097	0.030	-0.247	0.012	0.136	0.236
	0.233	0.377	0.347	0.075	0.980	0.013	0.534	0.846	0.110	0.937	0.385	0.128
14	0.238	-0.287	-0.120	0.207	-0.057	0.229	0.207	0.089	.328*	-0.017	-0.007	0.037
	0.125	0.062	0.442	0.182	0.716	0.140	0.184	0.571	0.032	0.912	0.966	0.815
15	1.000	0.094	-0.148	0.005	0.139	0.080	0.132	.330*	-0.055	.353*	0.252	0.278
		0.550	0.345	0.973	0.374	0.612	0.400	0.031	0.728	0.020	0.103	0.071
16	0.173	1.000	0.117	-0.100	0.012	0.048	-0.228	0.129	-0.116	0.266	-0.016	-0.062
	0.110		0.454	0.524	0.939	0.759	0.142	0.411	0.458	0.085	0.921	0.691
17	.366**	0.064	1.000	0.228	0.095	0.003	0.279	0.120	-0.168	0.160	0.025	-.334*
	0.001	0.560		0.141	0.545	0.986	0.070	0.442	0.282	0.305	0.876	0.028
18	0.131	-0.022	0.027	1.000	0.111	0.028	-0.166	-0.070	0.155	0.155	-0.291	-0.026
	0.228	0.842	0.802		0.478	0.857	0.288	0.654	0.320	0.322	0.059	0.867
19	0.166	0.080	0.194	0.007	1.000	0.053	-0.073	-0.085	-0.103	0.139	0.080	0.263
	0.126	0.463	0.073	0.947		0.734	0.640	0.590	0.511	0.375	0.608	0.089
20	0.126	-0.008	0.166	-0.035	0.210	1.000	0.106	0.154	0.139	-0.056	0.114	-0.020
	0.246	0.943	0.127	0.751	0.052		0.500	0.323	0.376	0.719	0.467	0.900
21	0.029	-0.002	0.136	-0.100	-0.082	0.046	1.000	0.200	0.007	0.181	.380*	-0.152
	0.791	0.989	0.212	0.361	0.450	0.671		0.198	0.964	0.247	0.012	0.330
22	0.034	0.123	0.085	-0.146	-0.009	-0.046	.408**	1.000	-0.106	0.115	.681**	0.070
	0.757	0.259	0.436	0.181	0.937	0.676	0.000		0.498	0.464	0.000	0.657
23	.232*	-0.091	0.187	-0.144	0.203	.329**	-0.112	-0.084	1.000	-0.090	-0.211	-0.164
	0.032	0.405	0.085	0.187	0.061	0.002	0.306	0.441		0.565	0.175	0.294
24	0.119	0.190	-0.015	-0.126	.307**	-0.118	0.003	-0.036	0.155	1.000	0.267	-0.067
	0.277	0.079	0.888	0.247	0.004	0.280	0.976	0.743	0.155		0.083	0.668
25	0.180	.344**	.226*	-0.017	-0.100	-0.038	.220*	.502**	0.082	0.098	1.000	0.061
	0.098	0.001	0.037	0.873	0.357	0.726	0.041	0.000	0.451	0.368		0.697
26	-0.110	-.248*	0.035	-0.126	-0.022	0.003	-0.009	-0.049	0.044	0.042	0.002	1.000
	0.314	0.021	0.749	0.249	0.841	0.980	0.935	0.655	0.688	0.699	0.988	
27	0.160	0.117	0.087	0.037	.402**	0.120	-0.040	0.124	0.151	.320**	0.206	-0.058
	0.141	0.285	0.425	0.734	0.000	0.273	0.717	0.254	0.166	0.003	0.057	0.593
28	0.100	-0.080	-0.054	-0.083	-.228*	-0.035	0.116	0.072	0.057	-0.138	0.102	0.057
	0.357	0.462	0.621	0.448	0.034	0.751	0.287	0.511	0.602	0.204	0.349	0.602
29	0.088	0.078	0.070	0.151	-0.067	-0.043	0.014	-0.166	-0.029	0.163	-0.088	-0.103
	0.419	0.473	0.523	0.164	0.538	0.696	0.898	0.128	0.793	0.133	0.421	0.346

Item	13	14	15	16	17	18	19	20	21	22	23	24
30	0.199	0.071	0.172	0.033	0.008	0.022	0.054	-0.097	0.192	-0.034	0.105	-0.095
	0.066	0.515	0.114	0.766	0.941	0.839	0.624	0.375	0.076	0.757	0.338	0.384
31	0.076	0.005	-0.015	0.024	-0.060	0.115	-0.031	-.230*	-0.012	-0.036	-0.142	0.159
	0.484	0.962	0.894	0.828	0.586	0.292	0.777	0.033	0.910	0.742	0.192	0.144
32	-0.004	0.174	0.001	-0.155	0.088	-0.024	-0.037	-0.164	-0.106	-.239*	0.086	0.077
	0.970	0.108	0.990	0.155	0.420	0.829	0.734	0.130	0.329	0.027	0.432	0.482
33	-.246*	.421**	.354**	0.044	.426**	0.133	0.166	0.101	0.020	0.065	0.118	0.093
	0.023	0.000	0.001	0.689	0.000	0.220	0.127	0.356	0.854	0.554	0.281	0.393
34	0.051	-0.091	-0.025	-0.009	0.181	-0.018	0.054	.229*	0.025	0.032	0.210	-0.154
	0.641	0.405	0.822	0.938	0.095	0.870	0.619	0.034	0.823	0.772	0.052	0.157

Item	25	26	27	28	29	30	31	32	33	34
1	0.010	-0.089	0.069	0.026	0.029	0.046	-0.058	-0.003	.370*	-0.012
	0.951	0.570	0.662	0.870	0.852	0.769	0.710	0.986	0.015	0.939
2	-.382*	-0.243	-0.238	0.138	-0.059	-0.068	0.078	0.129	-0.073	-0.133
	0.012	0.117	0.124	0.379	0.706	0.664	0.619	0.411	0.643	0.395
3	-0.008	0.053	-0.167	0.065	-0.032	0.188	-0.259	-0.214	0.031	-0.131
	0.961	0.734	0.285	0.680	0.839	0.228	0.093	0.169	0.843	0.402
4	0.144	0.191	-0.243	0.248	-0.180	0.107	-0.045	0.101	0.051	0.193
	0.356	0.220	0.116	0.108	0.249	0.495	0.775	0.519	0.747	0.215
5	0.123	-0.034	-0.192	-0.152	.319*	0.106	-0.096	-0.106	0.111	0.189
	0.434	0.827	0.218	0.330	0.037	0.499	0.539	0.501	0.478	0.224
6	0.200	0.093	-0.271	-0.284	-0.071	-0.239	-.417**	-0.122	0.223	.309*
	0.199	0.553	0.078	0.065	0.651	0.123	0.005	0.437	0.151	0.044
7	0.137	0.185	-0.031	0.103	-0.093	0.222	-0.211	-0.036	0.300	0.096
	0.379	0.235	0.842	0.512	0.554	0.152	0.175	0.818	0.051	0.542
8	0.000	0.116	0.061	.334*	0.018	0.094	-0.284	-0.062	0.200	-0.010
	1.000	0.458	0.700	0.028	0.908	0.548	0.065	0.693	0.199	0.948
9	0.143	-0.062	-0.077	0.168	0.024	-0.092	0.083	-0.061	.385*	-0.112
	0.360	0.693	0.626	0.282	0.877	0.557	0.598	0.699	0.011	0.474
10	0.101	0.045	-0.040	0.148	-0.067	-0.087	-.346*	-0.186	0.041	0.154
	0.520	0.775	0.799	0.344	0.672	0.577	0.023	0.233	0.792	0.323
11	0.226	0.004	0.164	0.068	-0.101	0.101	0.100	-0.095	0.106	-0.020
	0.146	0.978	0.292	0.664	0.518	0.520	0.525	0.544	0.498	0.899
12	-.339*	0.067	-0.277	.317*	-0.141	-0.036	0.068	0.016	-0.002	-0.056
	0.026	0.668	0.072	0.038	0.366	0.819	0.665	0.917	0.992	0.722
13	0.136	0.236	0.214	-0.062	0.158	-0.064	0.119	0.029	-0.043	-0.058
	0.385	0.128	0.169	0.693	0.311	0.684	0.449	0.855	0.783	0.710
14	-0.007	0.037	0.272	-0.032	0.024	0.111	-0.067	0.275	0.137	-0.024
	0.966	0.815	0.077	0.838	0.881	0.479	0.671	0.075	0.381	0.880
15	0.252	0.278	0.069	0.236	0.028	.356*	0.064	0.105	.410**	0.094
	0.103	0.071	0.659	0.127	0.857	0.019	0.683	0.505	0.006	0.550
16	-0.016	-0.062	0.190	.334*	0.078	0.174	0.293	0.077	0.123	-0.240
	0.921	0.691	0.222	0.029	0.620	0.264	0.056	0.625	0.432	0.121
17	0.025	-.334*	-0.071	0.086	0.051	-0.007	-.322*	0.010	0.016	0.013
	0.876	0.028	0.649	0.583	0.747	0.963	0.035	0.948	0.920	0.935

Item	25	26	27	28	29	30	31	32	33	34
18	-0.291	-0.026	0.120	0.091	-0.170	0.100	0.013	0.259	-0.014	-0.245
	0.059	0.867	0.445	0.561	0.276	0.525	0.932	0.094	0.929	0.113
19	0.080	0.263	0.199	0.009	-0.162	0.182	-0.034	0.139	0.271	-0.059
	0.608	0.089	0.200	0.953	0.299	0.243	0.829	0.374	0.079	0.709
20	0.114	-0.020	0.081	0.107	0.113	0.136	-0.019	0.229	-0.025	0.070
	0.467	0.900	0.604	0.493	0.471	0.386	0.902	0.140	0.874	0.657
21	.380*	-0.152	-0.139	-0.264	.368*	0.151	-0.276	-0.157	-0.033	.373*
	0.012	0.330	0.373	0.087	0.015	0.333	0.073	0.315	0.835	0.014
22	.681**	0.070	-0.123	-0.186	-0.015	0.185	-0.264	-0.146	0.214	0.134
	0.000	0.657	0.433	0.232	0.924	0.236	0.087	0.351	0.169	0.392
23	-0.211	-0.164	-0.083	-0.122	0.006	-0.092	-0.003	0.091	-0.129	0.123
	0.175	0.294	0.595	0.437	0.970	0.558	0.982	0.564	0.408	0.431
24	0.267	-0.067	0.140	-0.020	0.095	0.188	0.154	0.192	.317*	0.073
	0.083	0.668	0.370	0.898	0.544	0.226	0.325	0.217	0.038	0.643
25	1.000	0.061	-0.063	-.406**	0.142	0.036	-0.108	-0.106	0.207	0.154
		0.697	0.688	0.007	0.365	0.817	0.492	0.497	0.182	0.324
26	0.002	1.000	0.167	0.165	-0.193	0.213	0.024	-0.112	-0.027	-0.100
	0.988		0.285	0.289	0.215	0.170	0.877	0.476	0.864	0.524
27	0.206	-0.058	1.000	0.030	0.120	.337*	0.231	0.085	-0.120	-0.210
	0.057	0.593		0.846	0.442	0.027	0.136	0.586	0.442	0.177
28	0.102	0.057	-0.116	1.000	-0.139	0.162	0.267	.383*	0.062	-0.167
	0.349	0.602	0.287		0.374	0.300	0.084	0.011	0.691	0.284
29	-0.088	-0.103	0.022	-0.004	1.000	-0.022	-0.130	-0.233	-0.230	0.229
	0.421	0.346	0.839	0.968		0.890	0.407	0.132	0.137	0.141
30	0.105	-0.095	0.110	0.114	0.184	1.000	0.048	0.067	-0.014	-0.182
	0.338	0.384	0.313	0.297	0.090		0.758	0.668	0.929	0.242
31	-0.097	-0.001	-0.061	.278**	0.031	-0.120	1.000	.591**	0.024	-0.175
	0.376	0.994	0.577	0.010	0.775	0.272		0.000	0.880	0.261
32	-0.154	0.012	-0.107	.221*	0.145	-0.061	.414**	1.000	0.108	-0.218
	0.157	0.909	0.325	0.041	0.184	0.575	0.000		0.490	0.159
33	0.084	-0.199	0.098	0.043	0.133	0.119	0.189	0.171	1.000	-0.084
	0.441	0.067	0.369	0.692	0.223	0.276	0.082	0.115		0.593
34	0.050	0.166	0.081	0.059	0.037	0.067	-.279**	-0.159	-0.040	1.000
	0.647	0.126	0.461	0.591	0.733	0.542	0.009	0.143	0.716	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).