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Students' Discipline Specific Perceptions of Learning Practices

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Students' learning experiences shape their perceptions of effective learning practices, and these perceptions affect the effort and approaches students engage in when in a learning environment. The type of learning environment students engage with may vary across disciplines, therefore students' perceptions may be domain-specific. Data for this study were students' discipline-specific perceptions of effective course structures and activities for chemistry and humanities and their general epistemic beliefs. The responses (N = 532) across three courses were grouped as either constructivist or instructivist learning approaches and then reported as a ratio. A step-wise regression was used to determine domain-specific differences in the students' responses, and the association to epistemic beliefs and perceptions of learning. Results revealed disciplinary differences in students' perceptions of learning. Understanding students' perceptions of learning have implications for students' future enrollment, effort towards learning, and approaches to learning within different courses.

University students do not come to college as blank slates, but rather arrive with a history of schooling experiences that shape their perceptions of successful learning. Many of them may identify with a particular preference or belief about how to best process information (Willingham, Huges, & Dobolyi, 2015). Although their views of learning do not reflect their actual capabilities or dictate which approaches are best for learning performance (Alghasham, 2012; Cuevas, 2015), these beliefs about learning are important, because students' perceptions of learning environments are related to their approaches to learning and how they engage with their environment (Bandura, 1989; Ramsden, 1992). The approaches to learning in which students choose to engage are important; deep learning approaches, such as thinking critically about material and making connections to prior knowledge, are associated with better learning outcomes than more surface approaches, such as memorization (Felder & Brent, 2005). Both surface and deep learning approaches are often associated with different types of learning environments (Entwistle & Tait, 1990). Although research supports that deeper learning approaches are most consistent with constructivist learning environments (Freeman et al., 2014; Von Glasersfeld, 1996); instructivist learning approaches, which promote surface learning approaches, continue to dominate courses in higher education (Eagen et al., 2014). Within this study, a mixed-method approach explores students' perceptions of effective learning activities and course structures across three courses in two domains. These perceptions are matched with constructivist and instructivist views of learning and are related to a potential undergirding factor: students' beliefs about the nature of knowledge and learning.

Student Learning & Knowledge Beliefs

Perceptions of Learning. A common misconception about individuals is that they have a set learning style or strategy that is most effective for processing information (Pashler, McDaniel, Rohrer, & Bjork, 2008; Rogowsky, Calhoun, Tallal, 2015). Additionally, there are underlying assumptions about learning styles, including that they are generalizable and consistent across different subjects and are a reflection of an individual's cognitive abilities; however, scientific literature notes the lack of support for those assumptions (Willingham et al., 2015). To move further away from learning styles as part of a student's personal learning factors, it is encouraged to view students' perceptions of learning as learning preferences (Dunn, Beaudry, & Klavas, 1989; Willingham et al., 2015). Learning preferences can be broadly defined as one's predisposition for perceiving and processing information in a particular way or in a combination of ways; they are the learner's perspective, or beliefs, of what strategies are most effective for their learning (Sarasin, 1998).

A recent study has shown that course structures that account for individual learning preferences increase student-perceived autonomy, which contributes to deeper conceptual learning (Jang, Reeve, & Halusic, 2016). Increasing student autonomy is crucial in developing deeper conceptual understandings among adult students found in Higher Education courses; to achieve such an autonomy-supportive environment, students' perspectives must be taken into account (Ryan & Deci, 2000). This is not to say that courses should be completely structured to fit students' desires, as often touted by advocates of learning styles, as instructors and educators are still the experts on which methods are most effective for communicating a concept. Instead, understanding learner preferences can provide one piece of information that aids instructors in understanding the individual factors students bring to the classroom and use to construct the learning environment.

Epistemic Beliefs. In addition to the importance of learning perceptions and beliefs, domain-general beliefs about the nature of knowledge and learning, or epistemic beliefs, are additional personal factors that contribute to academic achievement (Hofer, 2000; Muis & Franco, 2009; Phan, 2008). Students' epistemic beliefs reflect a collection of independent beliefs about the nature of knowledge and the nature of learning (Olafson, Schraw, & Vander Veldt, 2010). These beliefs range from naïve to sophisticated perceptions of the process of learning (Quick learning), ability to learn (Innate Ability), source (Omniscient Authority), organization (Simple Knowledge), and certainty of knowledge (Certain Knowledge) (Schommer, 1990). Someone with sophisticated epistemic beliefs would believe "truth" is not always certain (CK) and that knowledge and learning are a complex process (SK), as opposed to someone with naïve beliefs would believe learning should be easy and quick, and people possess different inherent abilities (IA). Epistemic beliefs conceptualized as a continuum from naïve to sophisticated, or simple to complex, is not new (see Kuhn, 1991; Perry, 1970); however, more contemporary models view epistemology as multi-dimensional rather than unidimensional (e.g., Hofer, 2004; Muis, Bendixen, & Haerle, 2006).

Accounting for epistemological beliefs can provide insight into an individual's understanding of the nature of knowledge, including how to acquire and construct new knowledge. The individual dimensions of epistemic beliefs (e.g., CK, OA, and SK) are interrelated and when considered together are reflective of a students' belief about the way of knowing and learning (i.e., epistemic belief profile). These belief profiles can differ across disciplines. For example, a student may have sophisticated beliefs about learning chemistry (i.e., all five dimensions of epistemic beliefs) but a combination of naïve and sophisticated beliefs about mathematics. Students with more sophisticated belief profiles are higher achieving and motivated, implying that students' understanding of learning and knowledge contributes to their drive and performance in the classroom (Buehl & Alexander, 2005; Chen, 2012). Other studies have found that sophisticated beliefs are associated with greater use of self-regulatory strategies and deeper learning approaches, which positively affect academic achievement (e.g., Greene, Muis, & Pieschl, 2010; Hofer & Pintrich, 1997; Schreiber & Shinn, 2003; Vermetten, Vermunt, & Lodewijks, 1999). Further research is still needed to understand how these epistemic beliefs differ across disciplines and education levels, and how those beliefs affect deeper or more shallow learning approaches that ultimately shape learner success.

Epistemic Practices

Schommer's earlier work suggests that students' epistemologies can be seen in the actions they take or the strategies they use to learn. In line with this, Phan (2008) found that students' learning approaches mediate the relationship between epistemic beliefs and learning outcomes, further supporting the bi-directional relationship in Social Cognitive Theory between students' personal beliefs and learning approaches. Learning practices can be generalized as surface-level or deep. Surface learning strategies are based on rote memorization and are represented by actions, such as flashcards, mnemonics, and reading textbooks (Eagen et al., 2014). These shallow strategies have been associated with more naïve epistemic beliefs (Ravindran, Greene, DeBacker, 2005), further supporting the concept that students' beliefs play a role in their approaches to learning. In contrast, deep learning strategies, such as connecting prior knowledge and critical thinking, are associated with more sophisticated epistemic beliefs (Schreiber & Shinn, 2003). Other deep learning strategies, such as those present in self-regulated learners, are also seen in students with more sophisticated beliefs (Greene et al., 2010). This suggests that the actions students engage in when trying to learn new material are underpinned by their beliefs about the nature of knowledge and learning, supporting the concept of epistemic practices.

Students' perceptions of courses also differ by disciplinary field, particularly between soft and hard fields of study (Nelson Laird, Shoup, Kuh, & Schwarz, 2008; Ramsden & Entwsitle, 1981). Chemistry is considered a hard, Pure non-life science (Biglan, 1973). To be chemically literate, students need an understanding of key chemical ideas, what chemists do, essential skills, and chemistry environments (Bennett & Holman, 2002). Humanities and Social Sciences are academic disciplines categorized as soft, Pure life sciences (Biglan, 1973). Experts and professionals within both the hard and soft sciences do not drastically differ in their procedures for seeking new information or knowledge (e.g., reviewing published articles) (Ellis, Cox, & Hall, 1993); however, studies support the concept that approaches to problem-solving and critical thinking are domain-specific (e.g., Chi, Feltovich, & Glaser, 1981; Glaser & Chi, 1988). This suggests that across disciplines there are partial overlaps in strategies for communicating, constructing, and applying knowledge; however, the degree to which these communities of practice overlap across disciplines is not fully understood.

Epistemic Orientations

There is growing evidence that epistemologies are represented in a learning environment through course materials and structure and have an influence on students' own beliefs (Bendixen & Rule, 2004; Feucht, 2008; Haerle & Bendixen, 2008; Muis & Duffy, 2013).

For example, Muis and Duffy (2013) showed that students' epistemological beliefs shifted when within a constructivist learning environment, and this shift, or epistemic change, was associated with an increase in critical thinking and academic performance. Bendixen and Rule (2004) also found students' epistemic beliefs were influenced by the beliefs and actions of their teachers and peers. Both studies support the concept of epistemic orientations or an individual's epistemological alignments are based on the learning environment, practices, and structures at hand.

Similarly, the epistemic orientation of the activities in a classroom is a reflection of the teacher's understanding of the material and their own epistemological beliefs. A study by Chan and Elliot (2002) revealed that teachers' epistemic beliefs affect their understanding of course material and the strategies and practices they provide to their students. Furthermore, teaching and learning structures are related to students' beliefs about learning and approaches to learning (Gow & Kember, 1993; Kember & Gow, 1994; Kember, Leung, & McNaught, 2008). A study by Entwistle and Tait (1990) found students with preferences for deep learning approaches preferred active learning structures, in contrast with students with preferences for surface approaches who preferred rote learning structures. This does not mean students who prefer surface learning benefit best from that approach, but that their perceptions may influence student motivation for and perception of the course, which in turn has implications for effort and engagement (Cano, 2007; Floyd, Harrington, & Santiago, 2009). Teacher and student epistemic beliefs and learning preferences together contribute to the epistemic orientation of the classroom, or epistemic climate.

A classroom's epistemic orientation is present in the structure and types of assessment and activities it provides the learners. Historically, higher education learning environments have been oriented towards a teacher-centered structure or model of learning (Laurillard, 2002). This instructivist-based approach to learning assumes an authoritative and passive reception of information through memorization and recall, predominately given in the form of lecture, and leaves little room for discussion and real-world application (Archee, 2012; Porcaro, 2011). These kinds of environments promote the teacher as the knowledgeable authoritative figure, which suggests a more naïve epistemological orientation.

Contrary to traditional models of learning, constructivism emerged as a learning theory in support of more student-centered approaches based upon the notion that knowledge is socially constructed and builds on prior knowledge and experiences (Vygotsky, 1978). Specifically, Social Development Theory (SDT) acknowledges that learning is socially constructed through the culture of the classroom and social interactions: students (i.e., peer to peer), instructors (i.e., student to teacher), and other non-formal interactions (i.e., parents, siblings, self). This means that teachers are not the sole authoritative source of information, but students play an active role in the knowledge construction process, too. The theory also recognizes that types of academic engagement, such as persistence and frustration, and learning approaches are shaped by individual's zones of proximal development and perceptions (e.g., belief about ability), and available classroom resources (e.g., tools and supports to be successful). The theory aligns well with the idea that classrooms that take a more student-centered approach may have more sophisticated epistemic orientations through structures and activities that promote students to consider knowledge and learning as a complex and uncertain process.

Although the theory is in support of student-centered learning, it is worth noting that a single course can range in the degree of teacher-centeredness and student-centeredness throughout the instructional period based on the activities assigned. For example, one chemistry course could adopt two different models of learning: a teacher could have a lecture and then eventually transition students to a hands-on lab portion. Differentiating between different models of learning may be reflective of instructors adapting to the needs of the students or helping them maintain an ideal zone of proximal development (e.g., students may need direct modeling before attempting an experiment alone to stay engaged); however, instructors may perceive the need to differentiate for older students (i.e., those in secondary or higher education) differently than younger students. For example, an instructor in higher education may assume that because the students are older, they are capable of adapting quicker to the learning practices in order to be successful, whereas an elementary teacher may assume younger children need a variety of options to support their success. More research is needed to understand whether differentiated models of learning in a single course occurs similarly across disciplines and at the primary, secondary, and higher education levels.

Instructivism. Instructivism is also known as the traditional model of learning and historically has dominated K-16 classrooms. Most undergraduate courses consist of instructivist methods of learning, such as lectures, tutorials, and examinations (Laurillard, 2002). These traditional-style classrooms are teacher-centered and typically memorization-driven (Porcaro, 2011). The role of teachers in instructivist classrooms is to facilitate and transfer knowledge to students as directly and effectively as possible (Bednar, Cunningham, Duffy, & Perry, 1991), which assumes a view of knowledge as controlled and certain

(Fetherston, 2001). Common activities found in these types of classrooms are reliant on textbooks, repetition, individual work, and summative assessments. A course reflecting this type of structure limits student autonomy and interaction by relegating the student to a passive role in their learning (Jonassen, 1991).

Constructivism. Constructivist theories of learning reflect SDT and the idea that people construct their own meaning of knowledge from their interactions with the world, including collaborative interactions (Hartle, Baviskar, & Smith, 2012; Vygotsky, 1978). In contrast to those in instructivist classes, students in constructivist classes play an active role in the construction of their learning (Garrett, 2008). Common activities that reflect this view of learning include hands-on authentic practice, creation, argumentation, and perspective-taking (Choi & Lee, 2009; Papert, 1993). More authentic learning environments, such as those found in constructivist classrooms, focus on depth of knowledge over memorization and regurgitation, and emphasize the construction of knowledge based on prior experiences (Cox-Petersen & Olson, 2000). A meta-analysis conducted by Freeman et al. (2014) revealed undergraduate STEM courses that implement active learning approaches outperform traditional courses and are more likely to retain students. In addition to supporting academic performance, constructivist pedagogies also promote investigation and interpretation of information because of the collaborative and student-driven nature of those environments (Ertmer & Newby, 1993; Tom, 2015). The literature supports the notion that constructivist models of learning can benefit STEM and non-STEM learners' academic motivation and achievement, but the persistence of instructivist approaches across higher education STEM courses remains.

Purpose of the Study

There have been multiple national calls to increase student-centered strategies in the classroom (e.g., NSF, 1996; NRC, 1999, 2003), because these more interactive learning approaches have shown to positively change students' perceptions and success in fields with high attrition, such as STEM (Barcelona, 2014; Freeman et al., 2014). Today, almost half of the undergraduate chemistry courses still present information in an instructivist style and the other half have adopted some constructivist elements found more commonly in humanities-based courses (Stains et al., 2018). Despite the push from policy and researchers for more constructivist STEM environments, we know little about undergraduate students' perceptions of these courses. Exploring student perceptions of effective learning structures can provide insight into how students are motivated to approach learning a particular discipline, which has implications for future enrollment in courses with structures perceived as effective. Additionally, understanding these preferences may be especially important in the higher education context, where students expect and benefit from greater autonomy and the ability to contribute to instructional practices (Reeve, 2013). Grounding our work in Social Cognitive Theory and research on epistemic climates, we compare how students perceive effective learning structures and strategies across three different models of learning and two disciplines, and examine how these perceptions differ by course and student epistemic beliefs. Namely, we ask, 1) what do students perceive as effective chemistry and humanities course structures and practices?, 2) do these perceptions differ across course subjects?, and 3) how do these perceptions associate with student views on the nature of knowledge?

Methodology

Participants & Procedures

Participants for this study were 532 undergraduate students at a large southern four-year university. To be eligible to take the survey, participants had to be at least 18 years of age and enrolled in one of the participating courses during the fall 2017 semester: Chemistry 1 (Chem 1), Chemistry 2 (Chem 2), or Humanities & Social Sciences (HSS). No students appeared in more than one of the three courses explored in this study, and they were provided extra credit for their participation. Table 1 lists the demographics of the participants separately by course. Worth noting is that descriptively the demographics were similar across the three courses. For each course, around half of the students were Freshman and the other half Sophomore or older; however, three paired t-tests between the three courses revealed Chemistry 2 had significantly more students in total than both Chem 1 [$t(531) = -2.45$, $p = .01$] and HSS [$t(531) = -3.77$, $p < .001$]. Students were given two weeks to complete the survey via online email link; students read a consent document and then initiated the survey to provide consent to participate and permission for the researchers to access their academic records.

Materials

Course Syllabi. Each course instructor provided their syllabus, which included the course structure, activities, and grading practices. The syllabi were collected to allow us to determine the overall model of learning each course followed, as well as pedagogical commonalities and differences between two the courses within the same discipline.

Open-ended questions. The development of the researcher-created open-ended questionnaire was based on previous pilot-testing that used a sample of introductory chemistry students from a university on

Table 1
Descriptive Student Characteristics by Course

N = 532	Chemistry 1 N (%)	Chemistry 2 N (%)	HSS N (%)
Female	101 (60%)	97 (45%)	108 (74%)
White	131 (78%)	168 (77%)	116 (79%)
Freshman	97 (57%)	110 (51%)	79 (54%)
	M (SD)	M (SD)	M (SD)
HS GPA	3.70 (.21)	3.78 (.19)	3.67 (.21)

Note. HSS is Humanities & Social Sciences students. HS GPA = High school GPA; 29 students did not have their GPA available: 5 students from HSS, 12 from Chem 1, 12 from Chem 2. Chem1 N = 169, Chem 2 N = 217, and HSS N = 146.

the west coast of the United States. The questionnaire consisted of three open-ended questions, but for the purpose of this study we focused on the first two:

1. How are good [chemistry/humanities & social sciences] courses structured?
2. What are activities that help you learn about [chemistry/humanities & social sciences]?

Epistemic Belief Inventory. The Epistemic Belief Inventory (EBI), developed by Schraw, Bendixen, and Dunkle (2002), was used to assess students' general views of knowledge. The measure spans five dimensions of epistemology: Quick Learning (learning speed), Certain Knowledge (knowledge ambiguity), Simple Knowledge (knowledge structure), Innate Ability (learning control), and Omniscient Authority (source of knowledge). Each dimension comprised three, five-point Likert-scale questions, for a total of 15 questions.

Analysis

Phase 1: Qualitative.

Syllabus. The syllabus for each course was analyzed separately using a conventional content analysis approach for factors that shaped the format and structure of the course (Rosengren, 1981). Guided by the characteristics of instructivist and constructivist learning frameworks, the three courses' learning models appeared to fall on a spectrum ranging from a teacher-centered approach to student- and community-centered approaches (See Figure 1). All courses did include some form of lecture, reflecting traditional aspects of learning. The two chemistry courses had identical grading/assessment structures in place, and both included readings and practice problems; however, with the inclusion of the lab portion, Chemistry 2 included more constructivist practices. The HSS course differed the most by emphasizing writing-based assignments, group discussions, and guest speakers in the course structure. Because of the differences across all three course structures, we made the decision to analyze the courses separately.

Open-ended. The open-ended course structure and course activity questions were analyzed using thematic analysis. The two open-ended questions were coded separately to ensure the robustness of the codes. An initial sentence-by-sentence open-coding scheme was used, allowing each student to have multiple codes per response. First, an initial number of open codes from the course structure question for the three courses were found: HSS (N= 93), Chem 1 (N = 102), Chem 2 (N =1 83). Examples of different codes across the three courses include, "stories of other's experiences", step-by-step instructions", and "efficient lecture". The open codes for the activities question were then determined: HSS (N = 56), Chem 1 (N = 62), Chem 2 (N = 96). Examples of open codes from the activities question include "mnemonics", "outlines of important material", and "interviewing experts in different fields".

An axial coding process was then used to group the open codes based on common characteristics. The number of themes synthesized across course structure were: HSS (N = 16), Chem 1 (N = 17), and Chem 2 (N = 18). Theme numbers for activities were: HSS (N = 17), Chem 1 (N = 11), and Chem 2 (N = 15). A second round of axial coding was then used to combine any common codes across the three courses for course structure (N = 20) and activities (N = 17), which was then re-applied to all responses. These common characteristics constructed themes that differed in active versus passive learning preferences and aligned with Vygotsky's (1978) Social Development Theory. Lastly, using this framework, selective coding enabled us to relate both the course structure and course activities' themes to either instructivist (Herrington & Standen, 1999) or constructivist (Jonassen, 1991) models of learning.

Phase 2: Quantitative.

Open-ended Transformation. To integrate the qualitative and quantitative analyses, the codes that

Figure 1
Undergraduate Courses Model of Learning by Learning Factors

Course Factors		**Chemistry 1**	**Chemistry 2**	**Hum. & Soc. Sci.**
Structure	Lecture	✓	✓	✓
	Lab	X	✓	X
	Seminar	X	X	✓
Activities	Readings	✓	✓	✓
	Practice Problems	✓	✓	X
	Guest Speakers		X	✓
	Hands-on Activities	X	✓	✓
	Class Discussions	X	X	✓
Grading	Exams	75%	75%	X
	Quizzes	15%	15%	X
	Homework	10%	10%	X
	Writing *Reflection*	X	X	70%
	Analysis	X	X	16%
	Group work	X	X	14%
Model of Learning		**Teacher-centered**	**Student & Teacher-centered**	**Student & Community-centered**
		← **Instructivist**		**Constructivist** →

Note. Each course provided the syllabus, or semester outline, that contained course structure, activities, and grading assessments. These three factors were noted, and the table above reflects the differences found across the three courses. X = Not present, ✓ = present

were created during the axial coding phase of the qualitative analyses were transformed; each axial code was coded as either 0 (not present) or 1 (present) for each student response. It is worth noting that students who responded in more detail to the questions tended to have more codes present. Once transformed, the percentage of students reporting each theme was calculated. A second coder, an undergraduate researcher who coded the prior pilot-study themes, was used to ensure interrater reliability and quality of the codes created. Cohen's Kappa statistic was calculated to determine consistency among raters. The interrater agreement was greater than 80% for all course structure themes and greater than 86% for all activities themes. For codes with discrepancies between coders, a final decision was made by the lead researcher. Because both the course structure and student responses contain both instructivist and constructivist practices, a ratio score was calculated to represent each student's ratio of views (constructivist:instructivist ratio).

Epistemic Beliefs. The score (1-5) for each of the three questions were averaged to determine each students' degree of naivety (or sophistication) for each dimension. The Cronbach alphas for each subscale were: certain knowledge ($\alpha = .50$), innate ability ($\alpha = .71$), omniscient authority ($\alpha = .61$), quick learning ($\alpha = .65$), and simple knowledge ($\alpha = .69$). These alphas are consistent with those obtained in other studies using these measures (e.g., DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008).

Results

Students' open-ended responses that addressed our first research question, what do students perceive as effective chemistry and humanities course structures and practices?, aligned with both constructivist and instructivist approaches to instruction (See Table 2 and 3). Both classes of chemistry students reported a larger portion of instructivist preferences for their course structures and learning activities than did humanities students. In particular, repetitious activities, such as practice problems, were almost exclusively noted by the chemistry students, as discussion activities were by the HSS students. The differences in the HSS responses compared to chemistry responses suggested domain-specific perceptions of learning, which we explored next.

Interestingly, the pedagogical/learning practice not often discussed in the literature that was present in both student responses and in the HSS course syllabus was community-based. For example, within in Table 2 and Table 3, “guest speakers” or “community events”, were responses found only within HSS students and only within the HSS syllabus. Considering most high school and introduction college courses are taught in a traditional format, and students come to the classroom with these limited experiences, community-based learning structures are likely novel experiences to most Freshmen. Such early university exposure to community-based instructional practices may increase student expectancy and/or preference for this format for subsequent courses, which is likely a positive outcome if future courses also include this structure.

Table 2
Portion of Student Perceptions of Learning for Course Structure Themes

Course Structure

Theme	Chem 1	Chem 2	HSS	Sample Quote
Instructivist				
Self-Assessment Activities	9%	15%	3%	“Practice tests”
Practice Activities	30%	35%	9%	“Time to complete practice problems the correlate to the topic in class”
Examples/Walk-throughs	33%	21%	1%	“Examples with step-by-step instruction.”
Direct/Simplified Instruction	49%	50%	28%	“Teacher stands up and teaches on a topic for a large period of time.”
Review Activities	13%	15%	0%	“Reviewing content”
Organized/Structured	10%	14%	8%	“Rigid guidelines”
Constructivist				
Hands-on/Application	10%	11%	10%	“Hands-on experimentation/learning activities.”
Interactive/ Discussions	7%	4%	40%	“Class discussion because I like engaging with my classmates.”
Expand Perspective/ Open Enviro.	1%	0%	21%	“Open different students' attitudes.”
Cumulative/Connecting Material	5%	12%	0%	“Explains the interrelation of concepts.”
Promotes 21st Century Skills	0%	0%	13%	“Comprehension, and analytic skills.”
Other				
Affective	4%	4%	11%	“Strong student/teacher relationship.”
Teachers	7%	5%	10%	“It depends heavily on the style of the professor.”
Supplemental Resources	5%	18%	3%	“A useful textbook or other resources.”
Guest Speakers	0%	0%	3%	“Keynote Speakers.”
Other/Vague	10%	7%	12%	“Structured well.”

Note. Humanities & Social Sciences (HSS) students ($N = 146$), Chem 1 students ($N = 169$), and Chem 2 students ($N = 217$).

Table 3
Portion of Student Perceptions of Learning for Activities Themes

Activities Theme	Chem 1	Chem 2	HSS	Sample Quote
Instructivist				
Memorization/Review	25%	24%	4%	"Flashcards."
Lecture	5%	11%	17%	"The professor explains the subject."
Self-Assessment	4%	2%	2%	"Allow the students to test their knowledge."
Examples/Guided Practice	22%	28%	5%	"Have hints to point me in the right direction."
Practice Problems	63%	62%	1%	"Practice problems! Practice problems! Practice problems!"
Constructivist				
Discussion	1%	0%	25%	"Class discussion of concepts."
Interactive/Group Activities	6%	17%	21%	"Lots of group work to allow students to learn from their peers."
Hands-on/Application	15%	19%	20%	"Doing it first-hand."
Writing Activities	8%	6%	8%	"[Writing] a paper on scholarly articles."
Perspective Taking	0%	0%	6%	"Learning about the various different opinions students have on the topic."
Relate to Prior Knowledge	1%	1%	0%	"Connect a concept to something I've experienced or am familiar with."
Other				
Reading Activities	7%	15%	15%	"Reading articles or the textbook."
Community Activities	0%	0%	18%	"Events hosted by the various Humanities departments, or guest speakers."
Multimedia Resources	15%	10%	18%	"Watching crash course videos."
Affective	1%	1%	5%	"class more engaging and fun"
Other/Vague	0%	1%	3%	"I don't know."

Note. Humanities & Social Sciences (HSS) students ($N = 146$), Chem 1 students ($N = 169$), and Chem 2 students ($N = 217$).

Domain-Specific Differences in Perceptions

To answer research question two, Do these perceptions differ across course subject?, we explored the percentage of students reporting each number of constructivist and instructivist preferences reported by course using histograms. Over 80% of the HSS students reported no instructivist responses, and chemistry students reported a wider range and robustness in instructivist responses. This relationship appeared inverse for constructivist responses, with over 50% of Chemistry 1 students and 40% of Chemistry 2 students reporting no constructivist responses. The polarization of the learning preferences between the chemistry and HSS students is suggestive of disciplinary differences, and may also be a reflection of preferences that were informed by their course experience as reflected in the syllabus. To confirm these disciplinary differences, we then explored the descriptive statistics of the constructivist and instructivist themes across courses (See Table 4). A oneway ANOVA was conducted to reveal any statistically significant differences in the courses [$F(2, 529)= 133.32$, $p = <.001$]. Tukey posthoc mean comparisons revealed HSS differed significantly from Chem 1 ($p < .001$, $p < .001$) and Chem 2 ($p < .001$, $p < .001$) for instructivist and constructivist, respectively. These differences highlight that students in HSS courses have proportionally larger preferences for constructivist approaches, and students across different chemistry courses adopt proportionally larger preferences for instructivist approaches.

Because no differences were found between Chemistry 1 and Chemistry 2 across both constructivist and instructivist responses, we made the decision to collapse both chemistry courses into a single subject, "Chemistry". Additionally, the ratio of constructivist to instructivist themes was calculated for each student to represent their views of learning to account for differences in student response robustness. We then conducted a multiple regression of the constructivist:instructivist ratio on course subject, controlling for race, gender, and Freshman status (See

Table 5). We made the decision to control for Freshman status, race, and gender, because of gender and racial disparities often found in STEM courses compared to humanities-based courses, and potential differences in perceptions of college learning practices for first-semester Freshmen vs. more experienced students. The results of the multiple regression explained 24% of the variance in students' views of learning ($R2 = .237$, $F(4, 527) = 40.80$, $p < .001$). Looking individually at the predictors, course subject ($\beta = -.48$, $p < .001$) and Freshman ($\beta = .08$, $p = .049$) status statistically significantly predicted students views of learning. As we anticipated, discipline statistically significantly shaped perceptions, and students in the chemistry courses had views substantially more aligned with instructivist approaches; however, Freshmen tended to have more constructivist views. Being a Freshman means limited prior exposure to new college-level disciplines (e.g., Chemistry or HSS), which means their preferences and perceptions of learning at this point in their academic career are likely dependent upon high school experiences and assumptions/expectations of what learning in a discipline should look like.

Learning Perceptions & Epistemic Beliefs

To answer the last research question, How do these perceptions associate with student views on the nature of knowledge?, we first explored associations between students' epistemic beliefs, Freshman status, domain subject, and the constructivist:instructivist ratio using pairwise correlations (See Table 6). Students' constructivist:instructivist views were significantly associated with the Chemistry subject, but no associations were found between views or subject and epistemic beliefs. The lack of association between views of learning or subject and epistemic beliefs suggest individual beliefs about knowing and learning do not necessarily influence preferences for learning within specific disciplines.

We then explored the descriptives among students' epistemic beliefs by course (See Table 7). Five one-way ANOVAs showed only omniscient authority beliefs statistically significantly differed by course [$F(2, 529)= 7.10$, $p = < .001$]. Tukey test pairwise posthoc means comparisons revealed Chemistry 1 students' views of omniscient authority (M= 3.08, SD= .69) were higher than those in Chemistry 2 (M= 2.84, SD= .69) and HSS (M= 2.84, SD= .69), suggesting Chemistry 1 students had more naïve views about the source of knowledge, or credibility in sources that relay information (i.e., experts or teachers), than HSS students. This means students in the chemistry course with the most instructivist and teacher-centered activities were more inclined to believe knowledge should be handed down from a knowledgeable source.

Table 4
Descriptive Statistics for Students' Views of Learning

	Instructivist		Constructivist	
Course	M	SD	M	SD
Chemistry 1	2.67[c]	1.46	0.54[c]	0.70
Chemistry 2	2.81[c]	1.53	0.70[c]	0.76
HSS	0.60[a,b]	0.86	1.66[a,b]	1.25

Note. Humanities & Social Sciences (HSS) students ($N = 146$), Chem 1 students ($N = 169$), and Chem 2 students ($N = 217$). M =mean, SD = standard deviation. Statistically significant differences in the means for each construct by course was calculated at the $p < .05$, [a] = different from Chemistry 1, [b] = different from Chemistry 2, [c] = different from HSS.

Table 5
Multiple Regression of Construct: Instruct Ratio by Subject

	b	B	SE
Chemistry	-91.14***	-0.48	7.35
Freshman	12.71*	0.08	6.44
White	-0.88	-0.01	7.76
Female	-1.75	-0.01	6.64
R2	0.24		

Note. Humanities & Social Sciences (HSS) students ($N = 146$), Chem 1 students ($N = 169$), and Chem 2 students ($N = 217$). Dependent variable scale is a ratio of views of learning where positive is more constructivist views.
* $p < .05$, *** $p < .001$.

Table 6
Pairwise-Correlations of Course Perceptions and Epistemic Beliefs

	1.	2.	3.	4.	5.	6.	7.
1. Chemistry	-						
2. Freshman	-0.01	-					
3. Construct:Instruct	-0.48[c]	0.08	-				
4. Certain Know	-0.02	0.05	-0.03	-			
5. Innate Ability	-0.01	0.03	-0.07	0.31[c]	-		
6. Omni. Authority	0.07	0.05	-0.07	0.18[c]	0.06	-	
7. Quick Learning	0.04	0.01	-0.02	0.20[c]	0.28[c]	0.08	-
8. Simple Know.	0.05	0.05	-0.04	0.21[c]	0.18[c]	0.31[c]	0.38[c]

Note. Humanities & Social Sciences (HSS) (N = 146), Chem 1 students (N = 169), and Chem 2 students (N = 217). Chemistry represents domain-specificity. Construct:Instruct is the ratio of students' reported constructivist to instructivist views of learning.
[a] $p < .05$; [b] $p < .01$; [c] $p < .001$.

Table 7
Descriptive Statistics for Epistemic Beliefs Dimensions by Course

	Epistemic Beliefs	M	SD	Min	Max
Chemistry 1	Certain Knowledge	2.57	0.71	1.00	4.33
	Innate Ability	2.35	0.81	1.00	5.00
	Omniscient Authority[b,c]	3.08	0.69	1.33	5.00
	Quick Learning	1.74	0.54	1.00	4.00
	Simple Knowledge	2.48	0.69	1.00	4.67
Chemistry 2	Certain Knowledge	2.43	0.68	1.00	4.67
	Innate Ability	2.46	0.83	1.00	5.00
	Omniscient Authority[a]	2.84	0.69	1.00	5.00
	Quick Learning	1.63	0.52	1.00	3.67
	Simple Knowledge	2.32	0.71	1.00	4.00
Humanities & Social Sciences	Certain Knowledge	2.53	0.68	1.00	5.00
	Innate Ability	2.43	0.84	1.00	4.33
	Omniscient Authority[a]	2.84	0.69	1.33	4.67
	Quick Learning	1.63	0.48	1.00	3.00
	Simple Knowledge	2.31	0.67	1.00	3.67

Note. HSS students (N = 146), Chem 1 students (N = 169), and Chem 2 students (N = 217). Lower scores for epistemic beliefs are associated with a more sophisticated view of knowledge. The Cronbach alphas for each dimension were also calculated: Simple knowledge (.65), Quick learning (.70), Omniscient Authority (.63), Innate Ability (.71), and Certain knowledge (.52).
Statistically significant differences in the means for each dimension by course was calculated at the $p < .01$, [a] = different from Chemistry 1, [b] = different from Chemistry 2, [c] = different from humanities.

To further determine the relationship between students' views of learning and their epistemic beliefs, a step-wise regression was used to reveal the strongest predictor of students' views of learning (See Table 8). Covariates that were significant in the first regression conducted to answer research question 2 were retained. First step results revealed a 1% improvement to the model fit from research question 2 for including epistemic beliefs ($R2 = .245$, $F(7, 524) = 24.24$, $p < .001$). The second step was added to test for an interaction effect as to whether this OA had a differential association with learning preferences by course because Chemistry 1 students differed from other students' beliefs. Results revealed no additional improvement to model fit from the addition of the interaction term ($R2 = .245$, $F(8, 523) = 21.18$, $p < .001$).

Discussion

Research Questions 1-3

RQ 1. This qualitatively-driven approach revealed that students' learning preferences largely fell into categories that either aligned with instructivist or constructivist models of learning. Interestingly, across the three courses, students noted a wide variety of types of structures and activities they believed would help them learn a subject; however, the HSS students reported more constructivist views, as opposed to the chemistry students' mostly instructivist preferences. Many of the instructivist:constructivist distinctions were consistent with surface and deep approaches to learning, previously found to be related to different types of learning environments (Entwistle & Tait, 1990; Freeman et al., 2014). The proportional difference in the student responses across the three courses suggested there to be discipline-specific differences in how the learning environments were structured, included students' perceptions of learning, or both.

RQ 2. The findings from the first research question enabled us to further explore the apparent discipline-specific perceptions and the extent to which course subject might associate with students' preferences. Analyses revealed that students within chemistry courses perceived chemistry learning to be most effective in a traditional setting with direct instruction and memorization-based techniques. Students learning humanities and social sciences perceived that domain to be one that is most effectively learned using interactive discussion and participation from students, teachers, and community members. Although the students were not asked to directly compare the subjects, the stark differences between the fields lend some support for differences across soft and hard science fields as found in studies such as Nelson and colleagues (2008). Additionally, Freshmen were significantly more likely to report a higher instructivist to constructivist ratio. We know Freshmen enter college with pre-conceived ideas about how a college course may be structured, as well the practices of different disciplines (e.g., "This is what chemists do to learn/do chemistry"). This is consistent with the literature that suggests students learn different effective learning practices over time (Pederson & Williams, 2004), which may change their preferences for those practices as they move through to upper-level courses.

RQ 3. Regarding research question 3, students in Chemistry 1 had much lower omniscient authority beliefs than the other students. This means that students within this course believe their instructor is their chemistry knowledge gatekeeper. This also supports findings from other studies that found instructor beliefs or structure to the course can influence their students' beliefs about learning (Bendixen & Rule, 2004). The other epistemic beliefs did not have associations with learning preferences; this was in contrast to what was expected based on prior research (Greene et al., 2010). It is possible that epistemic beliefs are not easily captured through self-report measures, as more researchers believe epistemic beliefs to be domain-specific (e.g., Muis et al., 2006) and topic-specific (e.g., Merk, Rosman, Muis, Kelava, & Bohl, 2018). Additionally, Freshmen were no more likely to have lower epistemic beliefs than upper-level students, which supports the notion epistemic beliefs are malleable over time and not stable or a consistent trajectory. This study provides further evidence that epistemic beliefs may be associated with choice in courses/disciplines, such that students with naïve beliefs may select disciplines dominated by instructivist practices.

Table 8
Step-Wise Regression of Students' Views of Learning on Epistemic Beliefs

	Step 1			Step 2		
Variable	b	SE	β	b	SE	β
Chemistry 1	-90.73[c]	7.21	-0.48	-91.65[c]	7.89	-0.48
Freshman	13.68[a]	6.44	0.08	13.59[a]	6.46	0.08
Simple Know	-0.89	5.26	-0.01	-0.93	5.26	-0.01
Quick Learn	5.55	6.91	0.03	5.39	6.94	0.03
Innate Ability	-7.48	4.21	-0.07	-7.33	4.25	-0.07
Omni Author	-3.58	4.90	-0.03	-3.96	5.08	-0.03
Certain Know	-3.45	4.98	-0.03	-3.56	5.00	-0.03
Chem1xOA				0.71	2.50	0.01
_cons	119.72	19.67		121.11[c]	20.28	
R2	0.25[c]				0.25[c]	

Note. $N = 532$. Dependent variable scale is a ratio of views of learning where positive is more constructivist views. Non-white male HSS students are the reference group. Chem 1 and Chem 2 were separated based on differences in Epistemic Beliefs across courses. OA represents Omniscient Authority. Lower scores for epistemic beliefs are associated with a more sophisticated view of knowledge.

[a] $p < .05$; [b] $p < .01$; [c] $p < .001$.

Limitations

Our study was limited in three main ways. First, the open-ended nature of the survey questions allowed students to choose to list as many, or as few, activities and structures they perceived as effective. This means some responses may have been inflated due to students responding in more detail, allowing for greater deviation in students' constructivist:instructivist ratio. Second, within our study, we were unable to disentangle whether student preferences were based on pre-existing factors (e.g., those who take chemistry courses are more likely to prefer instructivist practices) and student reporting based on the course structure of their current class. Third, the lower-than-desired alphas on three of the five epistemic beliefs subscales could have contributed to our failure to find links between other dimensions of epistemic beliefs and learning preferences. Even though alphas were consistent with other studies (e.g., DeBacker et al., 2008; Ravindran et al., 2005), measure reliability issues could be limiting the conclusions that can be drawn.

Conclusion

Within this study, we explored the role of epistemic beliefs in student preferences and beliefs within the context of their courses as guided by Social Cognitive Theory. In meeting this goal, several contributions are presented: first, the use of qualitative open-ended questions allowed for students to freely choose what activities and structures came to mind when thinking about effective learning approaches, which allowed for more flexibility and authenticity than permitted by closed-response questions used by many studies (e.g., OECD, 2013). Second, this approach allowed for a broader understanding of the reciprocal relationships between students' epistemic beliefs and perceptions, their approaches to learning, and their learning environments. Third, we were able to show how within a single course students of different years have different perceptions of learning. Lastly, our results shed a light on the possible influence the course structure (e.g., syllabus) might have on a students' perceptions of effective learning structures; however, to understand whether a courses syllabus truly affects students' perceptions of learning strategies for a particular course, exploring changes in perceptions over a semester should be considered.

By further exploring students' perceptions of effective learning across courses and disciplines, instructors and researchers can better understand how students' personal factors and beliefs engage with learning environments. Future researchers should consider the use of longitudinal or experimental research studies to test the directionality of these relations—it may be important to know which instructional practices hinder or foster transformations in students' perceptions of learning practices and beliefs. For university instructors who wish to foster more sophisticated epistemic beliefs, this study provides some evidence that these beliefs are associated with constructivist course practices, even within subjects such as chemistry, that may be dominated by instructivist practices and students with more instructivist preferences.

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