USING K-W-L REFLECTION TO DESCRIBE SELF-REPORTED KNOWLEDGE AT INTRODUCTORY-LEVEL ANIMAL SCIENCE COURSE ENTRY AND EXIT

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Abstract

Introductory-level animal science courses are taught at universities across the United States. These courses' foci typically include a broad range of topics, such as animal species and breeds, animal handling, and animal care. Such courses also provide opportunities to incorporate experiential learning practices, such as reflection. Conceptually undergirded by an adapted version of Boud et al.'s (1985) model of reflection, we used a written reflective tool (i.e., a *Know-Want to Know-Learned* [K-W-L] chart) within two different semesters' introductory-level animal science courses taught at Southern Arkansas University (SAU). We asked the undergraduate students enrolled in these course sections to complete their K-W-L charts at the beginning and at the end of their respective semesters. We used content analysis and coding procedures to analyze and organize our data. We found that students often entered into the *ANSC 1003: Introduction to Animal Science* course with at least some animal-related background, often sought to learn more about cattle, and most frequently indicated that they learned about animal reproduction and genetics as a result of their course experience. We recommend that our study be replicated with other populations of students enrolled in animal science courses both at SAU and elsewhere. We emphasize that our findings should not be generalized beyond the students included in our study.

Keywords: animal science; knowledge; reflection; change

Agricultural faculty have long expressed concerns regarding the demographics shifts of undergraduate agricultural students, particularly regarding students' agricultural backgrounds. For example, Marshall et al. (1998) expressed that such changes in students' backgrounds over the years has resulted in alterations to the approaches used when teaching agricultural subject matter, such as animal science. More recently, both Paudyal et al. (2021) and Rayfield et al. (2013) noted that a substantial percentage of undergraduate students have no (or a very limited) background in agriculture. Dale et al. (2017), who studied the agricultural literacy levels of freshmen students at a Land-Grant University (LGU), noted that such students frequently have rather limited levels of agricultural literacy. Similar to Dale et al. (2017), Colbath and Morrish (2010) assessed the agricultural literacy levels of freshmen students at a Non-Land-Grant College of Agriculture (NLGCA) and likewise found that such students are rather lacking in their agricultural literacy. These findings are rather troubling, particularly in the context of preparing university-level students for opportunities that support the agricultural workforce of the 21st Century (Stripling & Ricketts, 2016).

Providing agricultural students (regardless of their prior knowledge of or experiences in agriculture) with opportunities to develop and hone their agricultural subject matter knowledge is a critical role of agricultural instructors (Phipps et al., 2008). This is likewise true regarding the animal science profession. In the context of animal science, Reiling et al. (2003) indicated that providing agricultural students with experiences in working with animals, such

as animal handling exercises, is paramount to preparing them for career opportunities related to animal agriculture. Sterle et al. (2016) found that exposing students to additional opportunities in animal agriculture beyond their preconceived notions (in the context of their study, veterinary medicine) can be instrumental in helping students to make informed decisions regarding their future career paths and opportunities. Additionally, Malone et al. (2016) noted that engaging students in practical livestock production-oriented activities is a useful approach for expanding their agricultural subject matter knowledge. Paudyal et al. (2021) noted that undergraduate students' exposure to animal science curricula and learning activities have positive impacts on their perceptions of animal agriculture. Hence, it is reasonable to postulate that agricultural instructors who teach animal science courses at the university level should explore ways (including new and novel approaches to learning) to enhance agricultural students' subject matter knowledge development and retention (Coleman et al., 2023).

To more deeply involve students in agricultural subject matter and promote both agricultural literacy and technical agriculture skill competence development, agricultural instructors typically use a variety of approaches when providing instruction. These methods include lecture, demonstrations, and hands-on, laboratory-based experiences (Phipps et al., 2008). Further, student acquisition of agricultural knowledge and skills through experiences, such as via hands-on applications and reflective, experiential learning, is not a new concept (Coleman et al., 2023; Deslauriers et al., 2016). Experiential learning is commonly employed to facilitate agricultural instruction (Phipps et al., 2008). Estepp and Roberts (2011) emphasized that employing experiential learning principles, such as reflection, within university-level agricultural coursework helps students to better-comprehend agricultural subject matter and transfer it to new contexts as they matriculate through their undergraduate degree programs and begin their post-university careers.

Kolb (2015) expressed that reflection upon one's experiences and learning from them is a vital component of education. Reflecting on learning experiences has been used extensively by university-level agricultural faculty. For example, Smalley and Rank (2019) found that using reflective learning activities granted undergraduate students in an agricultural teacher education program opportunities to meaningfully explore and consider the realities of teaching agriculture in American public schools. Whitehair et al. (2020) noted that using pre- and post-course reflective exercises conducted throughout an agricultural teacher education course produced measurable changes in students' conceptualizations of agricultural mechanics as an agricultural subject matter area. In particular, Whitehair et al. (2020) considered this to be especially evident regarding the expansion of students' thinking about the various content areas that agricultural mechanics subject matter entails (e.g., welding and metal fabrication, small gas engines, renewable energy sources, etc.). A similar approach conducted within undergraduate-level animal science coursework may yield analogous findings.

Scott et al. (2023) suggested that incorporating experiential learning activities into introductory-level animal science coursework can positively impact student academic achievement. Further, Coleman et al. (2023) expressed that using intentionally-planned, structured experiential learning activities, such as written reflections, within animal science coursework can result in measurable subject matter knowledge gains. Considering the aforementioned literature, perhaps exploring the use of an experiential learning-focused, reflective learning tool within the context of a semester-long, introductory-level animal science course would yield insight into how undergraduate students' animal science knowledge changes as they immerse themselves deeper into the subject matter area.

Context of the Study

The animal science course addressed in our study (i.e., *ANSC 1003*: *Introduction to Animal Science*) was designed to introduce undergraduate students to a variety of topics relevant to animal science, such as: (1) livestock breeding and genetics, (2) livestock handling techniques, (3) historical developments in animal agriculture, (4) animal anatomy and physiology, and so forth. This course was previously taught by the last author of the present study while he was serving at Southern Arkansas University (SAU) as an Assistant Professor of Animal Science. Due to its introductory nature, the *ANSC 1003* course was part of the core agricultural courses taken by undergraduate students across all six agricultural degree programs offered by SAU (i.e., Agricultural Business, Agricultural Education, Agricultural Science: Animal Science Option, Agricultural Science: Plant Science Option, Agricultural Science: Poultry Science Option, and Agricultural Science: Pre-veterinary Option).

The *ANSC 1003* course met on Tuesday and Thursday mornings during each Fall semester. The ANSC 1003 course served approximately 80 undergraduate students and was divided into two lecture-focused, face-to-face sections. Each section contained roughly 40 students. Each section's course meeting lasted for 80 minutes, yielding roughly 160 minutes of lecture during each week. Beyond the lecture component of each course section, each student was also responsible for attending one 110-minute laboratory section each week. The laboratory sections were taught on Tuesday and Wednesday afternoons each week. The ANSC 1003 course instructor taught four laboratory sections each week. The laboratory sections each served approximately 20 students and took place in a variety of settings, such as SAU's beef cattle farm, the SAU Agriculture Building, and local industry settings.

Throughout any given week during a Fall semester, an undergraduate student enrolled in the *ANSC 1003* course could expect to receive up to 270 minutes of instruction and experiences in animal science. Throughout a 16-week semester, the same student would expectedly receive up to 4,320 minutes of instruction and experiences during the *ANSC 1003* course. Considering such, we expected that students enrolled in the *ANSC 1003* course would likely undergo changes in their knowledge of animal science as an agricultural subject matter area. However, exactly what might such changes (if any) entail?

Conceptual Framework

We adapted and used Boud et al.'s (1985) model of reflection as the conceptual framework for our study (see Figure 1).

Per Boud et al. (1985), "experience consists of the total response of a person to a situation or event: what he or she thinks, feels, or does and concludes at the time and immediately thereafter" (p. 18). Moreover, in alignment with Kolb's (1984, 2015) experiential learning theory, Boud et al. (1985) indicated that experiences and reflection operate in a feedback loop, with each informing the other. Ultimately, experiences and reflection work in tandem to produce a series of outcomes, such as individuals having new perspectives on some experience or concept, behavioral changes, and so forth.

Within our study, we contextualized Experience(s) Related to Animal Science as undergraduate students' enrollment and engagement in a semester-long, introductory-level animal science course taught at SAU during the Fall 2022 and Fall 2023 semesters. Specifically, we sought to explore these students' Ideas about animal science both at the beginning and at the end of the course. Similar to Whitehair et al. (2020), we used paper-based, reflection-focused graphic organizers in the form of Know-Want to Know-Learned (K-W-L) charts to help facilitate and document the Reflective Processes component of Boud et al.'s (1985) model. Regarding Course Learning Outcomes, we were specifically interested in undergraduate students' New Perspectives on Subject Matter, such as changes in their perceived knowledge and skills related to animal science, and their Readiness for Application of newly-learned animal science subject matter as they progressed further into their respective degree programs (e.g., enrolling in additional, higher-level animal science courses, completing an agricultural industry-based internship during an upcoming Summer semester, etc.).

Purpose and Research Questions

The purpose of our study was to assess how undergraduate students' animal science knowledge changed throughout a semester-long, introductory-level animal science course taught at SAU. We used three research questions to guide our study:

1. What knowledge about animal science did undergraduate students reportedly already have at the beginning of the *ANSC 1003* course?
2. What knowledge about animal science did undergraduate students want to gain throughout the *ANSC 1003* course?
3. What knowledge about animal science did undergraduate students reportedly gain by the conclusion of the *ANSC 1003* course?

Methods

Our study was qualitative in nature. Specifically, we used content analysis as our research approach. Drisko and Maschi (2016) defined content analysis "as a family of research techniques for making systematic, credible, or valid and replicable inferences from texts and other forms of communication" (p. 7). Content analysis can be useful in evaluating written works (such as K-W-L charts) to establish patterns (Drisko & Maschi, 2016), such as reporting frequencies of particular items noted by students. We used pre-made K-W-L charts (see Figure 2) consistent with those employed in Whitehair et al.'s (2020) study.

Figure 1

Adapted Model of Reflection (Boud et al., 1985)

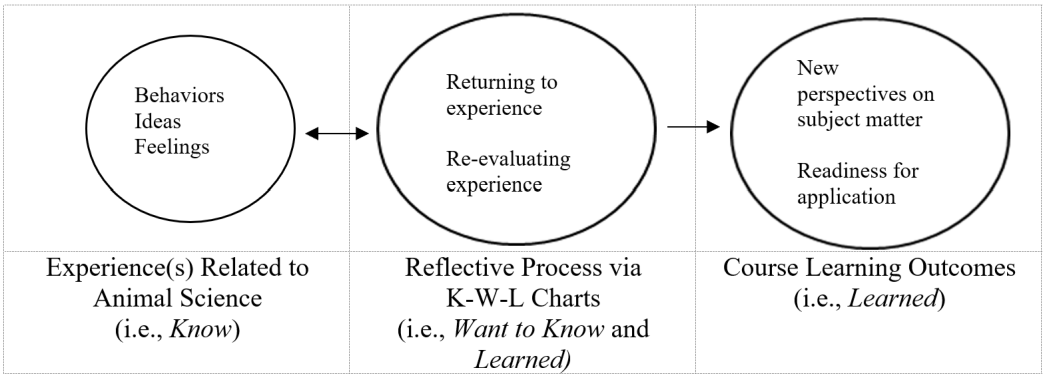

Figure 2

K-W-L Chart

Name:	Section Number: Sec. 1 (8:00 A.M.) or Sec. 2 (9:30 A.M.)	
Major:		
Year:		
August Date:	December Date:	
Knowledge about Animal Science now:	What you want to learn about Animal Science this semester:	What you learned in Animal Science this semester:

While our data sources (the K-W-L charts) were completed by undergraduate students as part of a regular in-class activity within the *ANSC 1003* course, we nonetheless sought (and received) Institutional Review Board (IRB) approval before we began examining the K-W-L charts. An undergraduate student studying pre-veterinary medicine never previously enrolled in the *ANSC 1003* course described in our study (the lead author), an agricultural teacher educator not affiliated with the *ANSC 1003* course (the second author), and an animal scientist who taught the *ANSC 1003* course described in our study (the last author) comprised the research team.

Data Collection

During the Fall 2022 and Fall 2023 semesters, the last author taught the *ANSC 1003* course at SAU. Eighty-two undergraduate students were enrolled in the *ANSC 1003* course during the Fall 2022 semester and 81 undergraduate students were enrolled in the *ANSC 1003* course during the Fall 2023 semester. At the start of the first course meeting of each semester, the last author distributed the K-W-L charts to the all students. The last author asked each student to report the following information at the top of their K-W-L chart: (1) first and last names, (2) academic major, (3) classification / year (e.g., freshman, sophomore, etc.), (4) course section number, and (5) the day's date. Afterward, the last author directed the students to address the following sections within their K-W-L chart: (1) "Knowledge about Animal Science Now" (i.e., the *Know* section) and (2) "What You Want to Learn about Animal Science This Semester" (i.e., the *Want to Know* section). Afterward, the last author collected the K-W-L charts from the students.

During the final regular lecture section meeting day of the semester, the last author distributed each student's K-W-L chart back to them. The last author then instructed the students to: (1) note the day's date at the top of their K-W-L chart and then (2) complete the "What You Learned in Animal Science This Semester" (i.e., the *Learned* section). The last author then collected each student's completed K-W-L charts and reviewed information regarding the *ANSC 1003* course final exam schedule and content. Once we received IRB approval to initiate our study, the last author compiled all 163 students' K-W-L charts, blinded each student's name, and coded each K-W-L chart via a semester and number system (e.g., 2022-07, 2023-22, etc.). We stored all blinded, physical K-W-L charts in a secure, locked location that only we could access. We stored all blinded, scanned K-W-L charts in an electronic storage folder that only we could access. We then initiated the data analysis process.

Subjectivity Statement

We do wish to note that, from the perspective of engaging in qualitative research, we each bring our own respective experiences and biases into our study. The lead author was, at the time of the study's conduct, an undergraduate student who has completed a litany of animal science and veterinary science courses as part of her undergraduate degree program. She never had any direct connection to the students enrolled in either section of the *ANSC 1003* course. The second author, an agricultural teacher educator, successfully completed various animal science courses as part of his undergraduate degree program and had taught animal science courses at the public high school in which he previously served as an agriculture teacher. The third author, an animal scientist, taught the *ANSC 1003* course from which we collected our data. We each value undergraduate student learning and wish for students in such courses to receive positive, impactful instruction in agricultural subject matter.

Data Analysis

We used a three-phase coding process to analyze our data. During the first phase of our coding process, we used open coding procedures to identify the frequency of specific topics within the K-W-L charts. During the second phase of our coding process, we employed focused, selective coding by identifying dominant topic frequencies to form clarified categories and themes. To aid in the data analysis process, we created broader categories to help reduce redundancies and provide greater clarity. For example, we used the theme "Nutrition / Feeding" to address a wide range of students' responses pertaining to the overarching topic (e.g., feeding horses, feeding cattle, etc.). During the third and final phase of our coding process, we used the identified themes to draw conclusions regarding patterns of change. We do wish to note however, that between both Fall semesters, a relatively high number of students dropped the *ANSC 1003* course from their respective schedules as the semesters progressed, which consequently led to a numerical decline of data reported throughout the subsequent sections of our study.

Results

Student Demographics

One-hundred-and-sixty-three students usable provided data for our study. Of these students, 66 students (40.5%) were majoring in Agricultural Science: Pre-veterinary Option, 42 students (25.8%) were majoring in Agricultural Business, 27 students (16.6%) were majoring in Agricultural Education, 22 students (13.5%) were majoring in Agricultural Science: Animal Science Option, and six students (3.7%) were majoring in other academic programs (e.g., Engineering, etc.) offered at SAU. Further, 130 students classified themselves as freshmen, 16 students classified themselves as sophomores, seven students classified themselves as juniors, and one student classified themselves as a senior. Nine students did not indicate their classification.

Research Question One: What Knowledge about Animal Science Did Undergraduate Students Reportedly Already Have at the Beginning of the ANSC 1003 Course?

We reported data pertaining to students' perceived knowledge about animal science prior to the course in Table 1. Regarding species-specific experiences, students most frequently reported having experience with cattle (*f* = 71; 43.6%). In contrast, students least frequently-reported poultry-related experience (*f* = 40; 24.5%). Regarding animal handling and care, students (*f* = 24; 14.7%) noted specific experiences with nutrition / feeding, reproduction / genetics, and exhibiting animals competitively. Twenty-two students (13.5%) reported having worked in a veterinary clinic before beginning their studies at SAU. Additional details about students' prior knowledge are detailed in Table 1.

Table 1

Students' Perceived Animal Science Knowledge Prior to the Beginning of the ANSC 1003 Course

Topic	f	%
Cattle-related experience	71	43.6
Horse-related experience	60	36.8
Administering injections/medications	50	30.7
Poultry-related experience	40	24.5
Hunting-related experience	38	23.3
Nutrition/feeding	24	14.7
Reproduction/genetics	24	14.7
Exhibiting animals	24	14.7
Worked at a veterinary clinic	22	13.5
Anatomical knowledge	17	10.4

These data were ascertained from the *Know* section of students' K-W-L charts.

Research Question Two: What Knowledge about Animal Science Did Undergraduate Students Want to Gain Throughout the ANSC 1003 Course?

We reported data regarding specific animal-related topics that students wanted to learn about throughout the course in Table 2. Students most-frequently indicated that they wanted to learn about cattle (*f* = 70; 44.3%). In contrast, students least-frequently reported that they sought to learn about the gastrointestinal (GI) tract. Additional details about students' learning interests are detailed in Table 2.

Table 2

Students' Desired Animal Science Knowledge Prior to Beginning of the ANSC 1003 Course

Topic	f	%
Cattle knowledge	70	44.3
Reproduction / genetics	45	28.5
Nutrition / feeding	40	25.3
Anatomical knowledge	31	19.6
Animal care / health	30	19.0
Anything animal-related	21	13.3
Administering injections / medications	19	12.0
Business / management	16	10.3
Related to job / major	16	10.1
Drawing blood	16	10.1
Hands-on / animal handling	14	8.9
Behavioral knowledge	11	7.0
GI tract knowledge	7	4.4

These data were ascertained from the *Want to Know* section of students' K-W-L charts.

Research Question Three: What Knowledge about Animal Science Did Undergraduate Students Reportedly Gain by the Conclusion of the ANSC 1003 Course?

We reported data regarding specific animal-related topics that students learned about by the conclusion of the courses in Table 3. Students most-frequently reported that they learned about reproduction / genetics (*f* = 80; 62.0%). Students least-frequently reported that they gained animal handling experience (*f* = 14; 10.9%). Additional details about students' knowledge acquisition are detailed in Table 3.

Table 3

Students' Perceived Animal Science Knowledge Acquisition at the Conclusion of the ANSC 1003 Course.

Topic	f	%
Reproduction / genetics	80	62.0
Business / management	60	46.5
Nutrition / feeding	54	41.9
GI tract knowledge	37	28.7
Drawing blood	34	26.4
Administering injections / medications	25	19.4
Poultry knowledge	22	17.0
Cattle breeds	17	13.2
Behavioral knowledge	15	11.6
Horse knowledge	14	10.9
Animal handling experience	14	10.9

These data were ascertained from the *Learned* section of students' K-W-L charts.

Conclusions, Discussion, Recommendations, and Limitations

The purpose of our study was to assess how undergraduate students' animal science knowledge changed throughout a semester-long, introductory-level animal science course taught at SAU. Based on our findings, we concluded that:

1. Students enrolled in the *ANSC 1003* course typically reported entering into the course with some baseline knowledge related to animal science. This most frequently manifested itself in the form of prior cattle- and horse-related experiences;
2. Students most frequently desired to learn about cattle, animal reproduction and genetics, and animal nutrition / feeding throughout the *ANSC 1003* course; and
3. Students most-frequently reported that they acquired new knowledge about animal reproduction and genetics, animal business and management, and animal nutrition and feeding by the conclusion of the *ANSC 1003* course.

We were not surprised by these findings, as these were the broad foundations upon which the structure of the *ANSC 1003* course was built. We did note, however, that there was some disparity between the animal science topics that students sought to learn more about (such as how animal science related directly to their academic major and the future career path) and what they actually reported learning about (such as poultry knowledge). It is conceivable that these students may have had somewhat overzealous expectations regarding the topics addressed throughout an introductory-level animal science course. It is also worth noting, however, that these students indicated that they desired relevance for the course content that they were preparing to learn.

We were further intrigued by students' limited reporting of newly-acquired animal handling knowledge. Instruction in appropriate animal handling is paramount to preparing students for success in animal agriculture (Reiling et al., 2003). Further, Malone et al. (2016) noted that incorporating livestock production-oriented activities into animal science courses is beneficial for students. Consequently, numerous laboratory sessions in the *ANSC 1003* course involved animal handling and management, such as flight zones, livestock facility use, and ear-tagging cattle. However, each laboratory session was comprised of at least 20 undergraduate students at any given time. Consequently, perhaps the high student-to-animal ratio contributed to this factor. Alternatively, though, perceived animal handling knowledge was reportedly lacking prior to the start of the *ANSC 1003* course, thus indicating that at least some students believed that their perceived knowledge on the topic was worth noting. Regarding actionable methods to address animal handling and management learning, perhaps using additional learning stations led by experienced, upper-division students could be a practical approach. Further, perhaps working with faculty in other disciplines (e.g., Agricultural Education) to make use of other human resources (such as undergraduate students majoring in Agricultural Education) to help facilitate the *ANSC 1003* course hands-on laboratory sessions would be useful for multiple parties as well.

In the context of Boud et al.'s (1985) adapted model of reflection, we found that using K-W-L charts to facilitate the reflection process was useful and informative for our practice. Estepp and Roberts (2011) noted that using experiential learning practices (such as reflection) in agricultural coursework is appropriate and useful. From the perspective of facilitating experiential learning activities in animal science coursework, we found that incorporating a structured, written reflection activity in accordance with Coleman et al.'s (2023) findings yielded insight into students' perceived animal science knowledge changes. Introductory-level animal science courses typically address a broad swath of subject matter designed to stimulate students' interest in the broader topic area and can serve as suitable vehicles for experiential learning (Scott et al., 2023). Hence, our approach to using a reflective tool to facilitate experiential learning appeared to have value for improving our understanding about student learning in these particular semesters' offerings of the *ANSC 1003* course.

We found it interesting that many of the students who provided data for our study are entering into an introductory-level animal science course reported having at least some prior experiences related to livestock and companion animals (e.g., cattle experience, working at local veterinary clinics, etc.). Perhaps they are acquiring these experiences through participating in family farm activities, part-time jobs during high school, or youth development organizations, such as 4-H, FFA, and so forth. We did not ask the students who provided data for our study to describe how or where they acquired their prior animal science knowledge. We also did not inquire what experiences stimulated their

interest in animal science. Consequently, these gaps in our own knowledge create potential areas of additional scholarly inquiry. Perhaps university faculty members who teach courses similar to the *ANSC 1003* course could incorporate a low-stakes, pre- and post-course concept inventory into their respective courses' activities to help learn about how students are compartmentalizing key course concepts, such as reproduction and herd health management. As the agricultural literacy of undergraduate students in a documented issue (Colbath & Morrish, 2010; Dale et al., 2017), deeper exploration of this subject is worth considering.

Regarding recommendations, we recommend that our study be replicated within introductory-level animal science coursework at other universities. However, we do recommend that other scholars (particularly those who teach introductory-level animal science courses) who replicate our approach also consider collecting data at the mid-point of the semester as well. Doing so may yield valuable insight into students' animal science knowledge acquisition, especially from a subject matter knowledge retention standpoint. We also recommend that the K-W-L charts we used in our study be employed within upper-level animal science courses at SAU and (and perhaps elsewhere) as well. Doing so could provide insight into changes in students' animal science knowledge as they move deeper into their agricultural degree programs.

Regarding limitations, the primary limitation that we wish to acknowledge was the limited scope of our study. We collected our data from students enrolled in the *ANSC 1003* course at SAU during the Fall 2022 and Fall 2023 semesters. Hence, we make no effort to generalize our results beyond the students enrolled in these particular courses. The secondary limitation that we wish to acknowledge was students' reporting of the topics on their respective K-W-L charts. For example, some students may have neglected to report some topics in the *Learned* column of the K-W-L charts due to honest error or forgetfulness. It is conceivable that the students enrolled in these courses may have actually learned or knew more (or perhaps less) than they actually reported. Third, the qualitative approach we used was in and of itself a limitation, as we do believe that studies using quantitative or mixed-methods designs may yield additional, useful data. Fourth, our lack of post-course subject matter knowledge retention follow-up was a notable limitation as well.

Methods

Introductory-level animal science courses can serve as vehicles for experiential learning practices, such as reflection on one's learning and prior experiences. We used K-W-L charts to facilitate this reflective component and found that students in an introductory-level animal science course reportedly acquired new knowledge in a range of animal science topics, such as reproduction and genetics, business and management, and nutrition and feeding. We plan to continue using this approach with future students enrolled in this course. We recommend that other scholars (especially those who teach similar courses elsewhere) consider using our approach as well.

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