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Incorporating research into the undergraduate wildlife management curriculum

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Abstract

We incorporated a course-based undergraduate research experience (CURE) into a Wildlife Management Techniques course to improve student skills and confidence in bird identification and research, study design, and scientific writing. The course objective was to provide hands-on experiences for students and give them exposure to field methods used in wildlife science. We added a bird observation study to the existing course curriculum where students formulated a research question, designed a 4-week study to address the question, and wrote a report in scientific journal style. Students (n = 38) were given a pre-survey and a post-survey with Likert statements and a quiz on bird identification. We expected that students would improve in their perceived confidence in science practices, knowledge of bird species, and interest in bird ecology. We observed improved perceived confidence in the science practice of data organization. Students improved their ability to identify bird species by an average of 18%. However, students had no change in bird ecology interest prior to and after the study. Eighty-nine and 97% of students agreed that the course helped them improve their bird identification and research skills, respectively. Adding this research experience allowed students to expand their skills, exposed them to research concepts, and provided a collaborative working environment that can make them more marketable for future employment or graduate school opportunities.

1 | INTRODUCTION

Experiential learning theory places experience as the key element in learning and acquiring knowledge (Kolb & Kolb, 2012). Knowledge is created by grasping and transforming these experiences through a student's immersion in the experience and actively or passively processing these experiences (Kolb, Boyatzis, & Mainemelis, 2001). Educators have placed much emphasis on promoting higher-order thinking strategies in the classroom to achieve an active-learning experience (Bonwell & Eison, 1991). Active-learning requires student involvement and engagement in experiences that go beyond traditional lecture-style teaching techniques to include cooperative projects, fieldwork, discussions, and other pedagogical approaches that

Abbreviations: AOU, American Ornithologists' Union; CURE, course-based undergraduate research experience; IACUC, Institutional Animal Care and Use Committee; KR20, Kuder–Richardson 20 formula; SURE, summer undergraduate research experience.

promote action by students and only guidance from instructors (Bonwell & Eison, 1991; Beard & Wilson, 2002).

Student-centered approaches to learning have been shown to produce creative, productive, professional, and responsible students ready for life beyond the university (Matter & Steidl, 2000; Moen, Boomer, & Runge, 2000). The active-learning style allows students to learn by doing and has shown high levels of retention and enthusiasm from students who have participated in such an approach to teaching (Millenbah & Millspaugh, 2003). Although it has been a positive step in building well-rounded students who are experienced with the skills and background needed to succeed beyond the university, there are often barriers that prevent educators from implementing this approach.

Implementing experiential learning in many undergraduate classes can pose considerable problems. Barriers surrounding decisions to implement these strategies within undergraduate course include added time for planning and in-the-classroom activities, budget concerns, and the instructor's comfort level with the material (Bonwell & Sutherland, 1996; Brownell & Tanner, 2012). Previous literature has provided models and recommendations such as the backward design and the course-based undergraduate research experience (CURE) logic model to cope with these barriers and highlights the potential benefits to students and faculty of this type of approach (Auchincloss et al., 2014; Bakshi, Patrick, & Wischusen, 2016; Cooper, Soneral, & Brownell, 2017; Corwin, Graham, & Dolan, 2015). Calls for reform in undergraduate biology education have pushed for what is known as CUREs (Auchincloss et al., 2014; Bangera & Brownell, 2014; Cooper et al., 2017; Corwin et al., 2015; Flaherty, Walker, Forrester, & Ben-David, 2017). Research experiences like CUREs have been utilized to emphasize the value of research in undergraduate courses while applying an experiential and active-learning approach. A CURE employs research practices in the classroom such as conducting broadly relevant research; addressing novel questions and generating hypotheses; collecting, analyzing, and interpreting data; and forming collaborative relationships (Auchincloss et al., 2014). Students benefit from CUREs by developing an understanding of the research process, developing their communication skills, identifying potential research careers, and improving their retention of science content, all of which are important, especially for underrepresented students who may not have the knowledge, tools, or guidance to pursue these opportunities outside of the CURE classroom (Bangera & Brownell, 2014; Kinkel & Henke, 2006; Lopatto, 2003; Lopatto, 2007; Millspaugh & Millenbah, 2004). Research experiences such as CUREs and other project-based learning experiences can be accomplished by providing a controlled active-learning environment where time dedicated to the activity is carefully planned and structured to keep both the educator and students on task (Bonwell & Sutherland, 1996; Cooper et al., 2017).

Core Ideas

- Course-based undergraduate research experiences (CUREs) promote inclusivity in scientific research.
- Research experiences expand skills and provides a collaborative working environment.
- Participation in research makes undergraduates marketable for employment or graduate school.

Pedagogy to promote experiential and active-learning has appeared in the wildlife education literature (Hiller & Tyre, 2009; McCleery, Lopez, Harveson, Silvy, & Slack, 2005; Moen et al., 2000; Ryan & Campa III, 2000). CUREs can be a system by which students can achieve course objectives while experiencing real-world applicability of their field of study. Undergraduate students often have mixed levels of experience and knowledge within a discipline (Day, 1997; Evans, 1987). In wildlife sciences, undergraduate students can vary in their exposure to study design, survey methodology, and species identification. Given that undergraduate wildlife courses (lecture only or laboratory) are often small (approximately 25–50 students) (Hiller & Tyre, 2009), there is an opportunity to integrate a CURE to ensure all students have research experience without the instructor being overwhelmed by a large class size.

A research experience within a particular location falls into the category of "place-based education." This location serves as the foundation upon which the curriculum is based (Jacobson, McDuff, & Monroe, 2006). Undergraduate students can further their professional development by practicing local wildlife identification and observation in a place-based project on or near their university campus. A wild bird observation study is an easy fit for a place-based CURE. Because wild birds are conspicuous in most environments, additional travel time and budgeting is not necessary, making a university campus or local park an easily accessible study site. In addition, a wild bird observation project may not require preparation of additional Institutional Animal Care and Use Committee (IACUC) paperwork for the CURE, as observation studies can be exempt from review at some institutions. Place-based CURE experiences can increase the relevancy and authenticity of the course content and emphasize the real-world learning that is found in an experiential environment (Jacobson et al., 2006; Woodhouse & Knapp, 2000).

We integrated a CURE into an existing Wildlife Management Techniques course in the fall of 2016. The upper-division course Wildlife Management Techniques (RWSC 3310) in the Department of Rangeland and Wildlife Sciences at Texas A&M University–Kingsville is a lecture–laboratory course aimed at providing students hands-on opportunities with techniques used in wildlife management such as capture, marking, and monitoring. The course is within the Range and Wildlife Management undergraduate program that serves approximately 200 undergraduates with class sizes that range from 20 to 70 students, with an average class size of 35 students. For the research experience, students worked collaboratively to develop and execute their own bird research project using the tools and skills learned in the course with instructor guidance.

Following the integration of this research experience, our main objective was to assess how this project influenced undergraduate students' affective (e.g., interest and self-efficacy; Eiss & Harbeck, 1969; Martin & Reigeluth, 1999; Van der Hoeven Kraft, Srogi, Husman, Semken, & Fuhrman, 2011), cognitive (e.g., knowledge; Cooper et al., 2017), and psychomotor (e.g., practical skills; Cooper et al., 2017) outcomes related to science practices and birds. This study was guided by the following questions: Will this research experience affect student (a) perceived confidence (i.e., self-efficacy) in study design, data organization, and scientific writing skills; (b) knowledge of bird species; and (c) interest in bird ecology? We expected that this research experience would:

- Improve the students' perceived confidence toward study design, data management, and scientific writing
- Improve students' ability to identify resident and seasonal birds
- Improve students' interests in bird ecology through increased birdwatching and attracting birds to their place of residence

2 | MATERIALS AND METHODS

Following general instructor and syllabus introductions on the first day of class, students were given a consent form and written pre-survey to complete. Of the 44 enrolled students, those who agreed (n = 38) signed the consent form and completed the pre-survey. Survey responses did not affect student grades. All students in the course were required to conduct a research project as part of their participation grade as suggested by Flaherty et al. (2017) in order to increase participation and motivation. Over the next 2 weeks, lectures and in-field or lab exercises were given on the topics of bird identification and survey methods, research and experimental design, and general project requirements. Students worked in collaborative teams of two to three students per group and were allowed to pick their research partner(s). One week later, student teams turned in a 1-page proposal that they co-authored with a partner and included the following information: research question, hypothesis, study site name and description, and bird survey method or protocol (example in Supplemental Material A). Example research questions included:

- Is bird activity affected by human traffic at the park?
- Does bird activity depend upon temperature?
- What is the impact of human disturbance on the relative abundance of avian species?

Supplemental reading materials, such as journal articles on methodology and bird survey research, were provided for guidance as suggested by Ryan and Campa III (2000). After proposal approval by the instructor, student teams independently conducted bird observations for 4 weeks with a minimum requirement of 15 observation minutes per week at their chosen study site in the South Texas region. All bird observations were approved by the IACUC at Texas A&M University–Kingsville under protocol numbers 2013-11-12-A3 and 2016-10-28. Students entered their data into a Microsoft Excel spreadsheet for descriptive statistical analysis and contribution to South Texas Wintering Birds, an eBird and Caesar Kleberg Wildlife Research Institute collaborative. Following completion of their bird observations, they had an additional 2 weeks to write a final report written in the *Journal of Wildlife Management* style (example in Supplemental Material B). Post-surveys (n = 38) were completed during the next class meeting, 7 days after all reports were collected. The entire project took place in 2 months from pre- to post-survey administration.

Pre- and post-surveys were identical with the exception of additional statements on the post-survey related to attitudes toward the course. Each survey had a total of 16 five-point Likert statements (post-survey had an additional two statements), yes-or-no questions related to their perceptions and interests in birds and science practices, and 20 color bird photos to identify (Supplemental Material C). Students were asked to respond to Likert statements that are meant to produce stand-alone responses with no attempt to combine responses into a composite score for each student (Boone & Boone, 2012; Clason & Dormody, 1994). Responses to Likert statements were similar to those originally developed by Likert (1932), ranging from *completely disagree* to *completely agree* on both surveys. Likert items had acceptable internal reliability (Cronbach's alpha = .52) for exploratory research (Nunnally, 1967). In our case, exploratory means that these Likert items have

TABLE 1 Twenty avian species that undergraduate Wildlife Management Techniques students (n = 38) were asked to identify by full common name as declared by the American Ornithologists' Union through colored photos on written pre- and post-surveys during fall 2016 at Texas A&M University–Kingsville

Avian species	Occurrence
Black-bellied whistling duck	resident
Black-crested titmouse	resident
Eastern phoebe	seasonal
Golden-fronted woodpecker	resident
Great kiskadee	resident
Greater roadrunner	resident
Green jay	resident
House sparrow (male)	resident
Inca dove	resident
Laughing gull	resident
Loggerhead shrike	resident
Northern bobwhite (male)	resident
Northern cardinal (female)	resident
Northern mockingbird	resident
Orange-crowned warbler	seasonal
Pyrrhuloxia (female)	resident
Turkey vulture	resident
Vermilion flycatcher (male)	seasonal
White-crowned sparrow	seasonal
White-winged dove	resident

not been used in or taken from an existing survey tool. Yes-or-no questions had an internal reliability of .39 using the Kuder–Richardson 20 (KR20) formula for binary or dichotomous outcomes (Auer et al., 2017). This KR20 value may be due to too few items in the measure or items supporting different constructs. All Likert items and yes-or-no questions were analyzed using an upper-tailed Sign Test to test for improvements in student responses from pre- to post-survey with the use of ordinal measurements (Conover, 1999). Summary statistics regarding ornithology course enrollment are reported as total students in the response category (yes-or-no) divided by the total number of participating students.

At the end of each pre- and post-survey, students were required to identify 20 common seasonal (present during the fall migration period and when this project was implemented) and resident bird species (Table 1) by color photos of adult birds in breeding plumage. These 20 bird species were chosen because of previous bird surveys in the area conducted by the primary author, and students are likely to encounter these species in urban and rural areas of South Texas. Color photos were printed on the survey page and also projected on the classroom screen as Microsoft PowerPoint slides for approximately 30 seconds each, one at a time, and were revisited at the end of the survey if students needed another look. Students were asked to identify birds by standardized common name based on the American Ornithologists' Union (AOU, 1983). Students were not asked to identify the sex of the bird species; however, for sexually dimorphic species, only one sex was shown in the photos (the sex of the bird in the photo is listed in Table 1). Bird species identification was not a requirement of this course since students would get that experience in an ornithology class so there was no incentive or need for the students to study these birds. With this in mind, the CURE post-test was a measure of their identification improvement based on the project or their developed interest in birds. Each survey was scored using a rubric for the 20 species presented. Each species response received a score of 0, 3, or 5 depending on the completion and/or accuracy of the name. A zero was given if the name was left blank, student wrote "I don't know" or "N/A," or if the species was misidentified completely. Three points were given if the student gave a partial name or taxonomic grouping (e.g., white-winged dove identified as "dove"). Five points were given if the student wrote the correct AOU full common name. Capitalization and minor spelling errors were not considered in the score. Inter-rater reliability was not calculated because only one person (primary author) scored bird identification responses for both the pre- and post-surveys. Pre- and post-survey bird identification scores were analyzed using a paired t-test and are represented as a percentage with a maximum possible score of 100%.

Student identity was kept anonymous by assigning each student a numerical code to match their pre- and post-surveys following their initial submission using their university identification number, which was unknown to the researchers. Consent forms and surveys were approved by the Texas A&M University–Kingsville Institutional Review Board protocol number 2016-070. All statistical analyses were conducted in SAS 9.4 (SAS Institute, Inc.).

3 | RESULTS

3.1 | Science practices

Student perceived confidence in writing a scientific article showed no improvement (T = 2, P = .48, Statement 1 in Figure 1). In response to having written in scientific journal format, there was a significant change (T = 8.5, P < .001, Question 1 in Figure 2) with the majority of students (75%) responding "yes" in the post-survey. Student perceived confidence in using Microsoft Excel significantly improved and was assessed as a measure of data organization ability (T = 6, P = .004, Statement 2 in

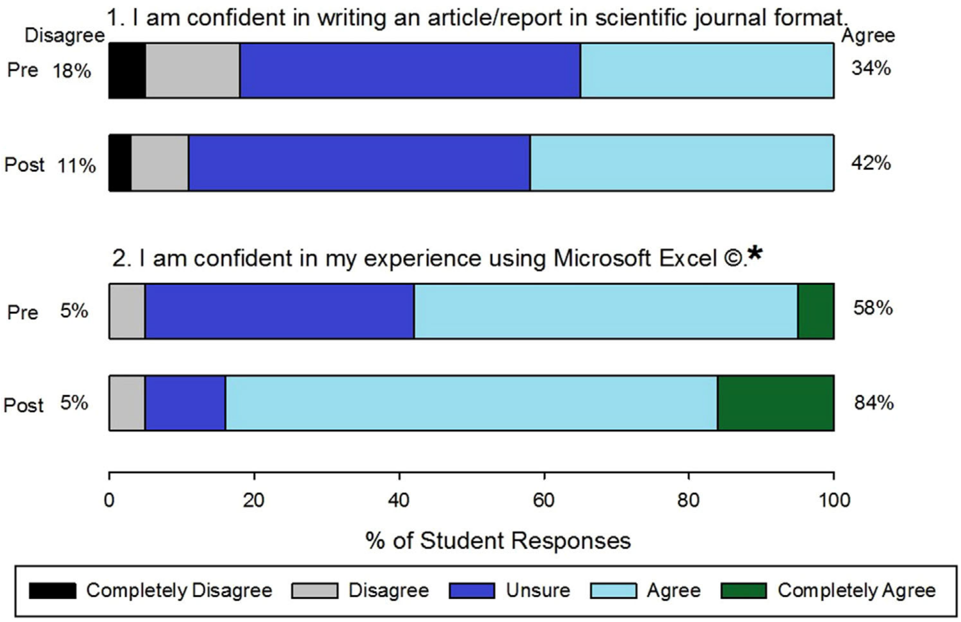

FIGURE 1 Percent of student responses (n = 38) to Likert statements regarding science practices on written pre- (top bar) and post-surveys (bottom bar) during the undergraduate Wildlife Management Techniques course at Texas A&M University–Kingsville in fall 2016. Percentage values on the left indicate the cumulative disagreement response (i.e., *disagree* and *completely disagree*) whereas percentage values on right represent cumulative agreement response (i.e., *agree* and *completely agree*). An asterisk following a statement indicates significant improvement or positive change

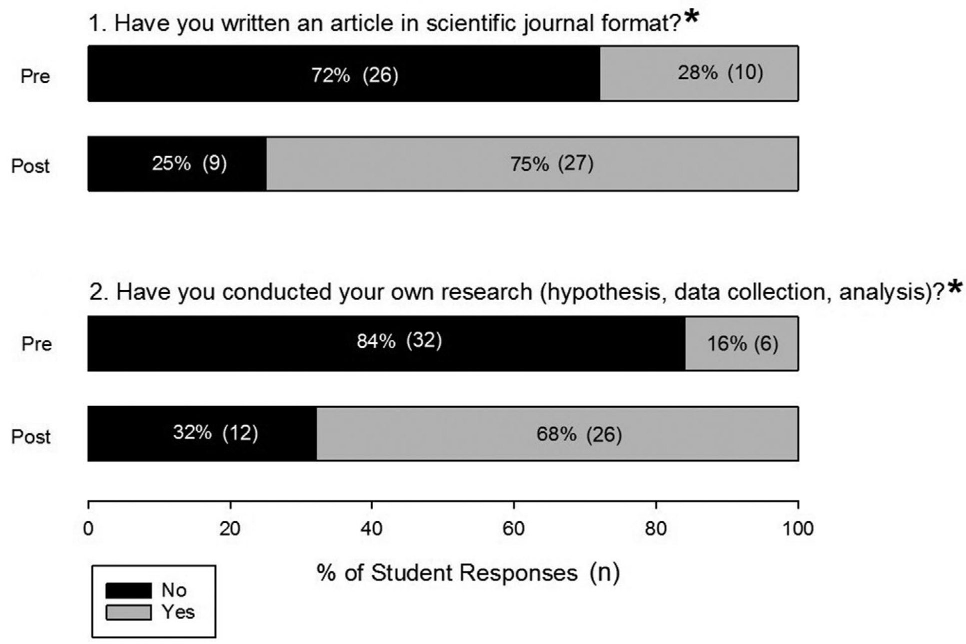

FIGURE 2 Student responses to yes-or no questions regarding science practices including previous writing experience in a scientific journal format (n = 36) and conducting their own research (n = 38) on written pre- (top bar) and post-surveys (bottom bar) during the undergraduate Wildlife Management Techniques course at Texas A&M University–Kingsville in fall 2016. An asterisk following a question indicates significant improvement or positive change

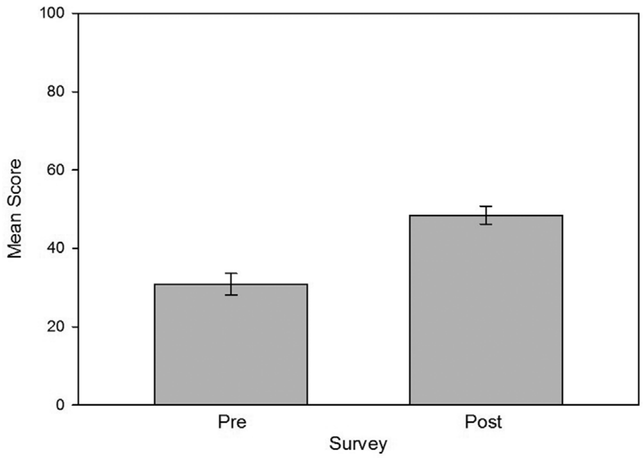

FIGURE 3 Mean scores (±standard error) for pre- and post-survey bird identification quiz for the undergraduate students (n = 38) in the fall 2016 Wildlife Management Techniques course at Texas A&M University–Kingsville

Figure 1). The majority of student responses (68%) changed to "yes" following the project, when asked if they have conducted their own research (T = 10, $P < .001$, Question 2 in Figure 2).

3.2 | Bird ecology and research

The pre-survey bird identification scores ranged from 0–79% with a mean score of 31%. The mean score on the post-survey was 49% with a low of 23% and high of 87%. On average, bird identification scores increased by 18%, a significant improvement in the students' ability to identify resident and seasonal birds (t = 10.28, $P < .001$, d = 1.66, Figure 3). The effect size for this analysis was found to exceed Cohen's (1988) convention for a large effect (d = .80). Students had no significant improvement in comfort level for setting up their own bird survey research project (T = 3, P = .26, Statement 1 in Figure 4). There was also no significant change in student interest in collecting data on birds (T = –.5, P = 1.00, Statement 2 in Figure 4). At the completion of the project, there was a 19% student increase in perceived confidence in their ability to identify many birds (>20) by full common name (T = 6.5, P = .01, Statement 3 in Figure 4).

Students were asked if they birdwatch outside of class activities, and there was no significant change in those who reported birdwatching (T = –3, P = .23, Question 1 in Figure 5). Even those that responded "no" to birdwatching initially (32%) were still interested in learning about them (Question 1b in Figure 5). Sixty-three percent of students responded "yes" to attracting birds to their place of residence on the pre-survey but following the project, the "yes" responses dropped to 42% (T = –4, P = .03, Question 2 in Figure 5). There was no difference in their comfort level of using binoculars at the conclusion of the project (T = 1, P = .75, Statement 4 in Figure 4).

Of all participants, only 8% of students reported taking an ornithology course prior to the Wildlife Management Techniques course. At the end of the course, 89% of participating students agreed that this course helped them improve their bird identification skills. Ninety-seven percent of the students agreed the course improved their understanding of bird surveys and experimental design.

4 | DISCUSSION

Benefits observed in other CURE projects (Elgin et al., 2016; Flaherty et al., 2017; Hanauer & Dolan, 2014; Kerr & Yan, 2016; Sarmah et al., 2016) were also present in this study. In addition to successfully integrating a bird observation study into an existing course as a research experience, students improved their perceived confidence in general study design and data organization, partially supporting our first prediction. They also improved their bird identification skills, which supports our second prediction. Although, students' perceived confidence in writing an article and setting up their own bird research project did not improve, they were given the opportunity to cultivate these skills. Our results also indicate that students' perceived confidence in identifying resident and seasonal birds improved, yet their interest toward bird ecology by birdwatching, attracting birds to their residence, and learning about birds remained similar and fails to support our third prediction.

More than 500 bird species have been documented in the South Texas region (Langschied, 2011). With so many species to learn, this research experience established a starting point for the bird identification learning process through real-world experience. Students showed an increase in their perceived confidence in identifying many (>20) birds; however, none of the students were able to fully identify all 20 species provided on the survey quiz. This may be a result of them misgauging their confidence or being overly confident, known as the Dunning–Kruger effect, and is common in self-reporting studies (Boud & Falchikov, 1989; Falchikov & Boud, 1989). It is also possible that students can identify other avian species that were not included in the 20 provided in this study. As a direct measurement of knowledge gains, students did increase their bird identification scores over the course of the research experience. Many students showed improvement in labeling species by full common name and by taxonomic grouping if they could not recall the entire name as dictated by AOU. Elementary and university students were asked to

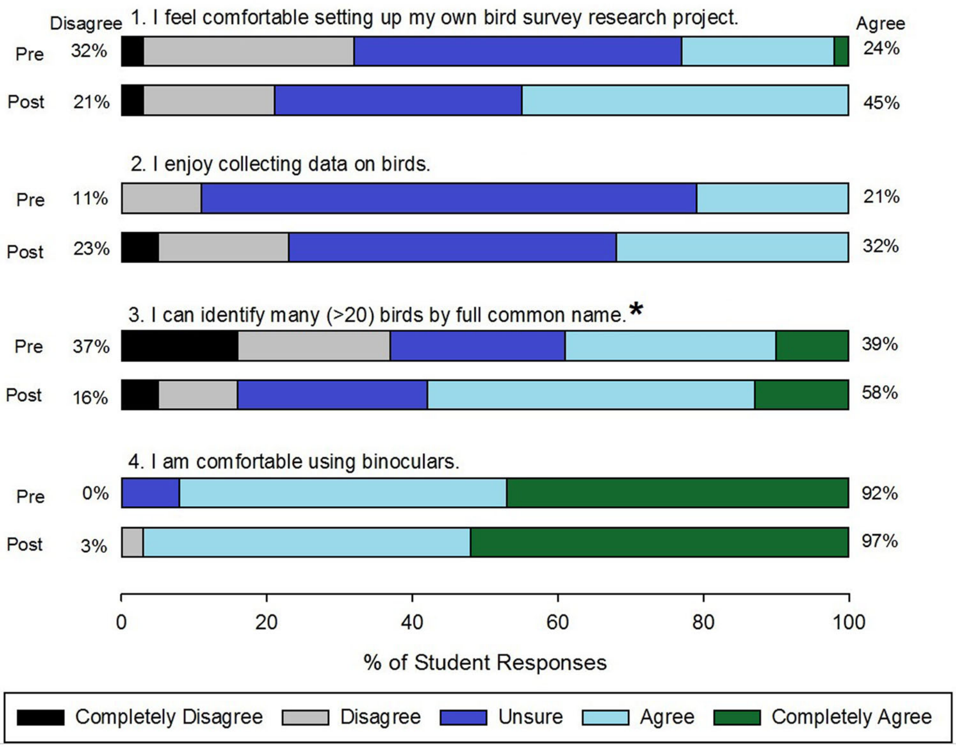

FIGURE 4 Student responses ($n = 38$) to Likert statements regarding bird research on written pre- (top bar) and post-surveys (bottom bar) during the undergraduate Wildlife Management Techniques course at Texas A&M University–Kingsville in fall 2016. Percentage values on the left indicate the cumulative disagreement response (i.e., *disagree* and *completely disagree*) whereas percentage values on right represent cumulative agreement response (i.e., *agree* and *completely agree*). An asterisk following a statement indicates significant improvement or positive change

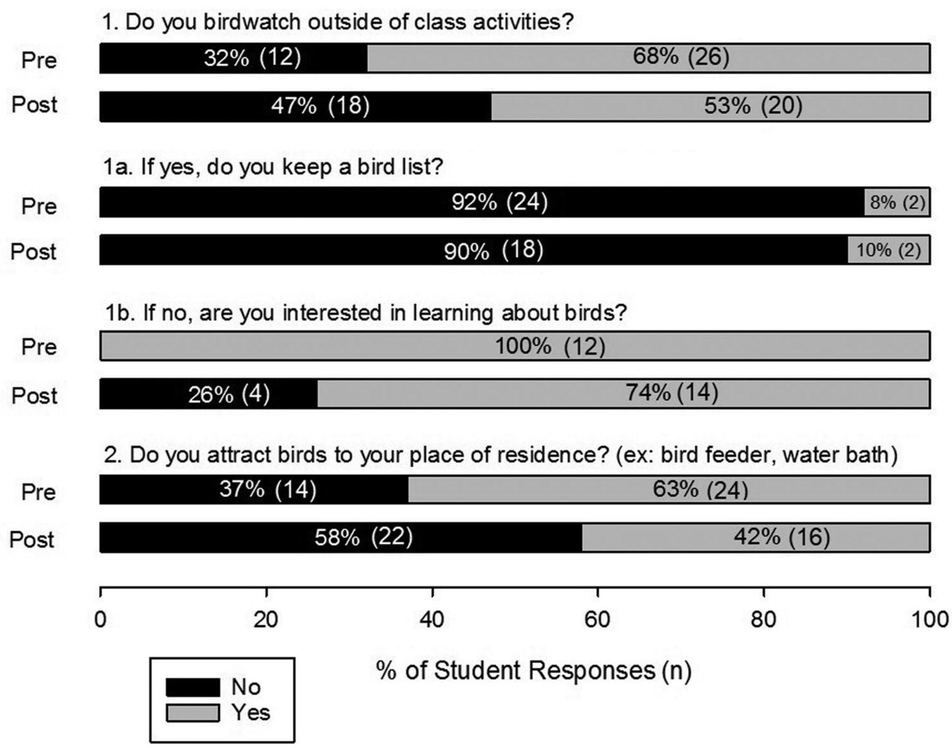

FIGURE 5 Student responses ($n = 38$) to yes-or-no questions regarding bird ecology on written pre- (top bar) and post-surveys (bottom bar) during the undergraduate Wildlife Management Techniques course at Texas A&M University–Kingsville in fall 2016

identify birds by song, growth, and both metrics. Students were able to identify 45% of birds by both metrics and correct identification declined with just song (19%) or growth (39%) (Prokop & Rodak, 2009), whereas Randler (2008) found in a much larger university classroom that identification scores increased from the pre-test (55%) to 80% on post-test when students were given slides and taxidermic specimens to study. Hidayat, Kurniawan, and Tapilow (2018) displayed differences in identification scores based on tools available for students to aid in their identification. Students using phone applications had an average score of 78% whereas those with only guidebooks scored an average of 72%. Variability exists in students' ability to identify birds and we must consider the tools and background knowledge accessible to them and the length of time in which students can practice these skills in order to gauge the development of their identification skills.

This CURE may also have unmeasured benefits such as improving students' science practice and observation skills. It allowed students to concentrate on details to identify birds and collect scientific data, which they can now apply to other focal species or animal groups of interest. Students may or may not have had a primary interest in birds, but up to 42% of students reported being interested in birdwatching outside of class activities and attracting birds to their place of residence on both surveys. Students who were not interested in this particular taxon may have carried this disinterest into their preparation and execution (i.e., identification practice, study design, data collection) of the project, leading to no improvement in their confidence. Projects based on instructor research interests may only benefit those concerned with the model species or taxa and may limit the impact the project has on others in the classroom (Cooper et al., 2017). Looking beyond student interest in the study taxa, using tools such as data management software to complete this project seemed easier to achieve during this research experience.

Data management is crucial to the organization and progress of a project; without it our outcomes can become erroneous and lack credibility. Students did improve their confidence in using the tools necessary to compile and organize their data (i.e., Microsoft Excel). Eichelberger and Imler (2016) found that traditional students tend to be more confident in technology skills as compared to nontraditional students, although they appear to be equivalent in the application of the skills. This suggests the presence of disparities in access to particular tools may be uneven across student populations. For example, the access to computers and software at home may be limited or nonexistent, which further emphasizes the need for these skills to be integrated and developed in the classroom. In addition, many students often become intimidated when having to develop their computer skills in the classroom (Farrell & Carey, 2018). Many at the undergraduate level have had very little to no exposure to the use of Microsoft Excel, which increases the amount of time spent troubleshooting, leads to increased anxiety, and takes away from their learning (Rubin & Abrams, 2015). Although Microsoft Excel may seem elementary—compared to Microsoft Access, for example—undergraduate students must begin developing those skills early to have an understanding and comfort in the full suite of tools that are available for research. Future work on data management should include not only collection, analysis, and visualization of data but also the preservation of it for a well-rounded experience (Carlson, Nelson, Johnston, & Koshoffer, 2015). Having the opportunity to use such a tool early in their academic career can be a great advantage in biology-related courses, in their preparation for graduate school, and an addition to resume skills for future employment.

The ability of students to set up their own research project takes time, experience, and a thorough knowledge of the scientific method. Although students' confidence in their ability to set up their own bird research project did not significantly improve, there was a slight increase in comfort (21%; Statement 3 in Figure 4). This demonstrates that some students may have improved in their confidence, but the overall student population in the course requires additional support in creating a project. Research experiences have been shown to improve student gains in self-confidence, research design and process, and disciplinary skills when participating in a summer undergraduate research experience (SURE) that allows for the development of mentor and peer relationships and exclusive research time without the presence of regular coursework (Lopatto, 2010). Kardash (2000) reported that undergraduates participating in a research experience rated their lowest skills as having to identify a question and formulate hypotheses. Furthermore, the process of testing hypotheses had the least improvement in self-perceived ability in various science process skills from the beginning to the end of a research experience (Kardash, 2000). Flaherty et al. (2017) argued that intimidation of designing and conducting their own project may impact student perceptions. Only 68% of the students reported having conducted their own research following project completion, although this was the intention to begin with. Remaining students may have not recognized their work as research, but simply an additional course assignment, and it may have been too limited in time for them to develop their confidence in research. It is important for the instructor to emphasize the scientific process and the students' involvement in research if a CURE is to take place in their classroom. The implementation of scaffolding activities across the curriculum may be beneficial for students to acknowledge research experiences and the development of their skills.

Additional challenges exist in implementing student research in the classroom. The presence of student resistance is also possible as some students may not like working with others or do not like being challenged and having to think on their own (Shortlidge, Bangera, & Brownell, 2016). More practice by ways of longer-term research projects or in-class brainstorming activities may be needed to further student confidence in the design of their studies. An alternative option would be to offer elective courses in research if institutional support is available and provide additional guidance in finding volunteer and internship opportunities that promote these topics. Programs should also strive to incorporate research in required courses in addition to electives, as students may opt to not enroll and, therefore, miss the opportunities provided (Bangera & Brownell, 2014; Cooper et al., 2017). Research has also suggested promoting independent research projects, but these independent projects can also be problematic. Independent research projects rely on students recruiting their own faculty advisor, which may dissuade students who feel uncomfortable approaching faculty with these requests (Bangera & Brownell, 2014). In addition, faculty may tend to approach their best students to participate in their research programs, giving only a selected few those experiences (Bangera & Brownell, 2014; Jones, Barlow, & Villarejo, 2010; McCleery et al., 2005; President's Council of Advisors on Science and Technology, 2012; Wei & Woodin, 2011; Wood, 2009).

Study design is a component of research that must be considered beforehand yet may need to be modified once a project has begun. Considering only 16% of students reported that they had conducted their own research at the start of the course and there was no significant improvement in their comfort of setting up a bird project, a high percentage of students (97%) agreed that the course improved their understanding of general study design and research methods. This may point to the beginning of understanding the scientific process, yet not being able to apply it quite yet. Personal–professional gains in conducting research often include the ability to think and work independently (Hunter, Laursen, & Seymour, 2006). The project presented here allowed students to develop their own question and structure their own study. Providing these opportunities has the potential to stimulate a sense of ownership of a project and increase student responsibility, which can lead to improved motivation, self-efficacy in scientific investigation, and potential persistence in the sciences (Auchincloss et al., 2014; Jeffery, Nomme, Deane, Pollock, & Birol, 2016). Giving students the opportunity to run a "pilot" study to test their design may give them the chance to determine what will "not work," allowing them to think critically about the components of their research and how they can improve them. This process mimics the scientific process and is an important component of a CURE. The exploratory nature of research gives these student scientists the ability to try alternative techniques to examine their question, providing them real-world practice as stressed by the experiential learning theory.

Real-world practice is necessary to prepare students for their future professions in which writing is deemed a pertinent skill and may be one of the most valuable experiences that is relevant to their career (Moen et al., 2000). Experiential learning theory calls for authentic experiences that are unique and include tasks that pertain to the real-world (Hung, Tan, & Koh, 2006). In fact, writing may be the most relevant and valuable skill students can acquire (Day, 1997). Although many students reported that they had never written an article at the start of the project, this research experience gave them experience writing in scientific journal style. Their perceived confidence in writing did not improve in this study nor was this skill highly rated in previous research experiences (Hunter et al., 2006; Kardash, 2000). It is important to note that a majority of students recognized their writing as being formatted for a scientific journal; however, 25% did not, which can be attributed to their lack of awareness of the publishing process, the instructors' lack of emphasis on the purpose of formatting, or the students' misunderstanding of the question. Asking students to write in scientific journal format has been previously shown to increase project ownership, participation in the scientific community, and persistence in science (Corwin et al., 2015; Lave, 1991). By including this writing component into an existing course, we avoided the addition of specialized courses to the curriculum, such as technical writing, that may extend a student's stay at the university or deviate from the course load required for the major program (Elsen, Visser, & van Driel, 2009). To expand this experience, future studies should include a peer review step, which will mimic the professional process many scientists encounter when publishing their research. Ryan and Campa III (2000) suggest students take full advantage of the revision process and urge instructors to require multiple versions of graded writing to keep students motivated. With encouragement and constructive criticism, students can become better writers (Day, 1997).

We recognize self-reported gains in student learning, experience, and confidence is not an accurate way to measure student outcomes. Disadvantages exist with self-reporting such as dishonesty, carelessness, and other misleading effects (Borg & Gall, 1983). Further empirical research is needed to measure true knowledge gained in these areas. We touched on this through our work with testing the technical skill of students on bird identification, but additional effort will be necessary to gauge improvement in writing, study design, and other science practices. It will be important to incorporate more than one measure to identify changes in perceptions and provide direct evidence of student outcomes (Corwin et al., 2015). In addition, the lack of control in this study did not provide the support we needed to reflect the true perceptions and interests that may exist with wildlife-minded undergraduates (Flaherty et al., 2017). It is difficult to accomplish this and increase our sample size at our institution due to the small student cohort in the program, only one course section available, and the risk of double responses from the same individuals since many of the same students take other wildlife courses in the same semester. Furthermore, our small sample size prevented us from improving reliability of our survey instruments. Additional implementation of the CURE across years may enable us to increase our tools' reliability. There is much room for additional study in the support of CUREs among the science disciplines in an effort to determine factors that may influence students in the sciences and their success.

Experiential and active-learning has been previously underutilized in the undergraduate wildlife curriculum due to time constraints, funding, and class size (McCleery et al., 2005). A hands-on research experience, such as the one described here, can be instrumental to the growth of undergraduate students, as these experiences are needed to prepare them for real-world situations. Learning opportunities that engage students in science are important to develop undergraduates who are responsible, goal-driven, and scientifically literate members of society (Matter & Steidl, 2000; Moen et al., 2000; Ryan & Campa III, 2000). A primary motivator to become involved in wildlife CUREs or independent projects is often a students' interest in animals. Consequently, instructors should cultivate this interest in nature to develop individuals who take conservation actions and are aware of environmental issues (Chawla, 1998; Owen, Murphy, & Parsons, 2009; Tanner, 1980). Integration of research into existing curricula may better prepare students for their future in wildlife by making research accessible, teaching critical thinking, forming collaborative relationships, and promoting awareness to the potential issues they may encounter as practicing scientists.

4.1 | Course recommendations

Many courses provide the tools students need to pursue research questions but may never give the opportunity to execute those tools. By restructuring an existing course into a CURE, students may be given that opportunity. The type of research experience presented here can be an easy fit in courses that have learning outcomes related to study and research design. The following are tips to help instructors who are interested in implementing a CURE in their classroom:

1. To re-structure an existing course, begin by evaluating the topics covered in the syllabus to see how they can be reorganized to provide all of the necessary information to the students early in the semester or quarter. Providing the required information to the students at the beginning of the course allows the remaining time for students to put together and conduct a short-term research project. This will require more initial planning and preparation time on behalf of the instructor before the start of the course (Cooper et al., 2017).
2. Consider providing students the flexibility in choosing their focal species or taxa, yet reminding them that they should be easily accessible, at no cost to the student or instructor, and observable for ease of IACUC approval in a short period of time. Another approach is for the instructor to select focal species or taxa early to gain approval of IACUC before the course begins and allow students to choose which they would like to participate in for the project. These approaches can motivate students to perform well in the course, increase their knowledge and retention of information on their species or taxa of interest, and improve classroom project diversity.
3. We also encourage instructors to provide opportunities for peer review and instructor feedback on all steps of the CURE, from the proposal stage to writing the final report.

Course-based undergraduate research experiences are an avenue for active-learning and provide students with authentic experiences to make them more marketable for future employment or graduate school opportunities (Miller, Hamel, Holmes, Helmey-Hartman, & Lopatto, 2013; Weaver, Russell, & Wink, 2008).

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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