

IMPACT OF CONCURRENT ENROLLMENT IN ANIMAL REPRODUCTION LABORATORY AND LECTURE COURSES



Ashley R. Hartman¹, David M. Grieger², and Karol E. Fike²

¹Pillen Family Farms and DNA Genetics

²Department of Animal Sciences and Industry, Kansas State University

Author Note

Correspondence regarding this article should be addressed to Karol Fike, Department of Animal Sciences and Industry, Kansas State University, 127 Weber Hall, 1424 Claflin Road, Manhattan, KS 66506. Phone: 785-532-1104. Email: karol@ksu.edu.

Conflict of Interest: The authors declare no conflicts of interest.

Abstract

An animal reproduction course is a common degree program requirement of animal science majors though variation exists as to how learning outcomes are achieved. Universities either offer laboratory experiences as a part of their lecture content or as a separate course, which may or may not be required depending on the university, and others offer species-specific reproduction courses as electives. At the study institution, student learning outcomes and structure of the laboratory course were designed to provide hands-on learning opportunities, which coincided with concepts discussed in lecture. A total of 307 students, of which 95 were concurrently enrolled in the laboratory and lecture and 212 were enrolled in lecture only, were included in the analysis. Students concurrently enrolled in laboratory and lecture had a greater ($P < 0.001$) final course percentage in the lecture compared with those enrolled in lecture alone. Students in the science degree option had a greater ($P < 0.03$) final lecture course percentage compared with those in the production degree option, and juniors had a greater ($P = 0.05$) final course percentage when compared with sophomores. At the end of the semester, students were surveyed about the perceived value of the laboratory course on their learning. Among students enrolled in laboratory sections, 98.4% indicated the hands-on activities improved their knowledge of course content in lecture. These student beliefs are supported by our results, which suggest taking the laboratory and lecture concurrently improves student final course percentages.

Keywords: undergraduate, animal science, teaching, animal reproduction, experiential

Animal reproduction is one of several animal sciences disciplines included in the program learning outcomes of the American Society of Animal Science Accreditation Standards for Animal Sciences program of which students earning a Bachelor of Science degree in Animal Science must demonstrate knowledge (American Society of Animal Science, 2020). Variation exists among accredited programs offering a Bachelor of Science degree in Animal Science as to animal reproduction courses delivered as lecture only or concurrent laboratory and lecture formats. Diverse backgrounds and previous animal experiences of undergraduate students require experiential learning to help prepare students for their futures (Buchanan, 2008; Ragland et al., 2023). Use of techniques such as field trips and hands-on activities found in laboratory courses increase classroom engagement and are among the most important teaching tools for animal science instructors (Buchanan, 2008; Ragland et al., 2023). The increasing variation in prior experiences with livestock handling has emphasized the need to teach practical application-type skills often learned in laboratories (Buchanan, 2008). When students are asked about their beliefs toward courses with livestock handling students responded that the experience was invaluable in their education (Woiwode, 2016).

Historically, laboratory courses have been used to provide students the opportunity to conduct scientific research, review peer writing, and develop skills for basic care of animals (Horvath & Inskeep, 1968). However, as students' needs change, altering course designs to provide more individualized hands-on learning may be more beneficial for the changing student demographics. Hands-on, or experiential, learning, is the act of performing a skillset

IMPACT OF ANIMAL REPRODUCTION LABORATORY

or learning by “doing” (Roberts, 2006). Examples of hands-on learning activities in animal science include any acts in which the student is able to execute or assist in a skill such as assessing vital signs, or assisting in parturition (Wells et al., 2019) which increase student engagement and enable them to reinforce course topics communicated in lectures (Ragland et al., 2023).

Factors that influence animal science course learning outcomes include gender, major, and college standing (Bormann et al., 2013; Burk et al., 2013; Lancaster & Robinson, 2011; McMillan et al., 2009; Peffer, 2011; Soberon et al., 2012). Yet to be investigated, is if an interaction exists amongst these factors and concurrent enrollment in a laboratory and lecture course as indicated by final course percentages. Hands-on activities in various fields of study such as science and engineering have been demonstrated to improve student engagement and learning (Handur et al., 2016; Haury & Rillero, 1994; Wells et al., 2019), however applicability of this effect to animal reproduction courses warrants evaluation. Understanding if and how hands-on learning activities increase student interest and motivation may lead to improved awareness of animal care and career preparedness (Ragland et al., 2023). Our study aimed to investigate the potential impact of concurrent enrollment in lecture and laboratory sections on student learning (as indicated by final course percentages) in an animal reproduction course.

Methods

This study was deemed exempt by the Kansas State University Institutional Review Board. Data were collected from participating students enrolled in the animal reproduction lecture and (or) laboratory courses at Kansas State University in the Department of Animal Sciences and Industry during the spring semesters of 2021, 2022, and 2023. The animal reproduction lecture is a 3-credit course required for the Animal Science major. The lecture course meets three times per week for 50 minutes. Student learning is assessed via performance on exams and quizzes.

The animal reproduction laboratory is offered as a 1-credit course only in spring semesters. It is an elective course for most students, except for those completing the Bioscience option within the Animal Science major, who are required to take the animal reproduction laboratory course. At Kansas State University, the Animal Science and Industry undergraduate program offers students five different degree options that require the animal reproduction lecture course. Of those five degree options, two are science-focused (Pre-veterinary Medicine and Biosciences), and the remaining three are production-focused (Production Management, Communication, and Business). The laboratory course meets once per week for 110 minutes. Students learning is evaluated via their performance on exams, quizzes, and laboratory exercises. The learning outcomes and structure of the laboratory course were designed to provide hands-on or experiential learning opportunities that coincided with concepts discussed in lecture. Examples of these learning opportunities include evaluation and dissection of non-pregnant female reproductive tracts, identification of male

reproductive tract anatomy, semen evaluation, male and female reproductive tract histology, embryo evaluation, building diagrams to demonstrate hormone feedback, and pregnant tract anatomy and dissection. The species used in the laboratory for dissections were bovine and porcine. When available, preserved specimens from other species were provided to students to learn about anatomy differences.

Data collected included individual students' final course percentages in lecture and laboratory, college standing (sophomore, junior, senior), gender, and degree option. Students' degree options were categorized into either a science (Pre-veterinary Medicine and Biosciences) or production (Production Management, Communication, and Business) focus. After agreeing to participate in the study, 307 students were included in the analysis, of which 95 were concurrently enrolled in the laboratory and lecture, and 212 were enrolled in lecture only. Students who agreed to participate in 2022 were also asked to complete a survey summarizing their perceptions of the courses.

The GLIMMIX procedure of SAS (version 9.4), was used to assess potential effects of factors on students' final lecture course percentage. Fixed effects included concurrent enrollment in laboratory and lecture, college standing, gender, degree option, and two-way interactions between concurrent laboratory enrollment and degree option, concurrent laboratory enrollment and college standing, degree option and college standing, gender and degree option, gender and college standing, and concurrent laboratory enrollment and gender. Utilizing backward selection, any non-significant ($P>0.05$) factors were removed from the final model. Frequencies were used to evaluate the proportion of student survey responses.

Results and Discussion

Potential two-way interactions (concurrent laboratory enrollment and degree option, concurrent laboratory enrollment and college standing, degree option and college standing, gender and degree option, gender and college standing, and concurrent laboratory enrollment and gender) were non-significant ($P>0.05$). Students concurrently enrolled in animal reproduction laboratory and lecture had a greater ($P<0.001$) final course percentage in the animal reproduction lecture course (82.88%) than those enrolled in lecture alone (77.66%). Other literature shows students who were given reading assignments in an animal physiology lecture course before quizzes had increased grade percentages (Horvath & Inskeep, 1968). Lugar et al. (2022) demonstrated a positive impact of providing written materials over pre-recorded lectures in a flipped classroom model of teaching, demonstrating the value of keeping students engaged in the material.

IMPACT OF ANIMAL REPRODUCTION LABORATORY

Table 1

Least square means (LSMEANS) for final lecture course percentages of students in animal reproduction

| Fixed Effects | n | LSMEANS Course percentage (%) | SE | P-value |
|---|-----|-------------------------------|------|---------|
| Concurrent enrollment in laboratory | | | | |
| Yes | 95 | 82.88 ^a | 1.31 | 0.001 |
| No | 212 | 77.66 ^b | 0.84 | |
| Animal science degree option ¹ | | | | |
| Production | 123 | 78.66 ^a | 1.20 | 0.028 |
| Science | 184 | 81.88 ^b | 0.93 | |
| Standing | | | | |
| Sophomore | 86 | 78.53 ^b | 1.32 | 0.049 |
| Junior | 144 | 82.42 ^a | 1.06 | |
| Senior | 77 | 79.87 ^{ab} | 1.43 | |
| Gender | | | | |
| Female | 231 | 80.36 | 0.90 | 0.830 |
| Male | 76 | 80.01 | 1.46 | |

Note. ^{a,b}Within a column and fixed effect, means without a common superscript differ ($P < 0.05$).

¹At Kansas State University, the Animal Science and Industry undergraduate program offers students five different degree options. Of the five degree options the science focused group included Pre-veterinary Medicine and Biosciences, while the production focused included Production Management, Communication, and Business.

In the present study, perhaps the learning material in the laboratory course had a similar effect to value of reading assignments in previous studies by reinforcing concepts from lecture. When hands-on activities were incorporated into a computer programming course, authors observed increased student final course percentages (Handur et al., 2016). Students enrolled in the laboratory may inherently have more motivation to learn than those not enrolled in the laboratory, due simply to more interest in the subject area and contributing to differences in grade performance. It is also possible that the improvements in learning from students participating in laboratory courses are due to increased engagement with the subject material, longer retention of course concepts, improvement in students' problem-solving skills, and that the laboratory allowed students more time to process material (Haury & Rillero, 1994; Gucwa & Cheng, 2014; Handur et al., 2016). Increased student engagement in reproduction courses has been shown to increase student grade percentage (Maiga & Bauer, 2013; Poole & Moore, 2016). Students given the opportunity to participate in review sessions and interactive flash games had an increase in exam grade percentages (Maiga & Bauer, 2013; Poole & Moore, 2016). While activities and review sessions facilitate student interaction with course material and engagement with instructors and peers (Maiga & Bauer, 2013; Poole & Moore, 2016), we expect that more substantive experiential learning occurred within laboratory sessions in the present study. Other animal reproduction courses have provided students with online laboratory material when it was not available in person, and observed that as students increased their interactions with the material

their exam percentages increased (Grizzle et al., 2008). However, the authors noted that it was difficult to recreate the hands-on laboratory sessions in an online format, perhaps emphasizing value of providing students with hands-on laboratory material with which they can physically interact.

Students in the science-focused degree options of the animal science curriculum in the present study had a greater ($P < 0.03$) final lecture course percentage (81.88%) when compared with those in the production-focused options (78.66%). The greater course percentage for students in the science-focused options is similar to the results of a previous study conducted at Kansas State University (Bormann et al., 2013). Bormann et al. (2013) classified student degree options as either pre-veterinary or non-pre-veterinary and found that students in the pre-veterinary options had greater final course percentages in a genetics course, similar to our results where students in the science-focused options had a greater final course percentage. Our results differed from previous literature evaluating agriculture courses, in which there was no association between major and course grade. Reasons for these varied conclusions may include that previous studies were focused on introductory courses, and the authors evaluated majors compared with non-majors, whereas we investigated specifically degree options within the animal science major (McMillan et al., 2009; Pratt-Phillips & Schmitt, 2009; Lancaster & Robinson, 2011; Soberon et al., 2012). Our findings of increased final course percentages by 3.2% for students enrolled in the science focused degree options may be because curricula include more biology, chemistry, and upper-level science courses than students completing the production-focused degree

IMPACT OF ANIMAL REPRODUCTION LABORATORY

options. Additional science courses may provide students with a stronger foundational knowledge in hormone chemistry and cell and tissue structures, for example, and thus reference points for understanding core concepts of hormone communication and reproductive tract anatomy in animal reproduction. Martin et al. (2006) found that students in an animal behavior course performed better after taking more than two science courses. Similar findings have been observed for anatomy and physiology courses, in which students who completed more mathematics and science courses performed better than those who did not (Harris et al., 2004). For instructors, realizing potential differences in preparedness and understanding of students based on their degree options may create a need to incorporate more background information, such as explanation of the chemical structure of hormones, for those students who may not have received it in previous courses. Students in the science focused option having a greater final course percentage may also be explained by their striving for acceptance into professional schools such as veterinary medicine and are likely more motivated in academic achievement.

College standing was another factor that significantly affected ($P < 0.03$) final course percentage. Students classified as juniors had a greater ($P < 0.05$) final course percentage (82.42%) than students classified as sophomores (78.53%) but did not differ ($P = 0.28$) from senior students (79.87%). Juniors would have completed more foundational courses than sophomores, perhaps providing them with a more robust science foundation. No difference ($P = 0.76$) was found in final course percentages when comparing seniors with sophomores. One explanation for not observing a difference between sophomore and senior standing is that this course is taught in the spring semester before graduation for most of these students, it is possible that this impacted their intrinsic motivation. Our results differ from Bormann et al. (2013) who found that seniors had the greatest course percentage in genetics, with no difference between juniors and sophomores (Bormann et al., 2013). Others have found no association between college classification and final course grades in plant science or other animal science courses (Lancaster & Robinson, 2011; McMillan et al., 2009).

Student gender did not affect ($P = 0.83$) final lecture course percentage. Other studies reported no associations between final course percentages in animal science courses and gender (Bormann et al., 2013; Burk et al., 2013; Peffer, 2011), whereas some researchers noted that female students achieved better grade outcomes than males in agriculture-related courses (Lancaster & Robinson, 2011; McMillan et al., 2009; Soberon et al., 2012), suggesting that the impact of gender on learning course concepts remains unclear.

Among students enrolled in laboratory sections, 97.4% indicated the hands-on activities improved their understanding of course concepts discussed in lecture.

Table 2

Summative perception of students who were surveyed in 2022 concurrently enrolled in the animal reproduction laboratory and lecture course about their beliefs towards the lecture and laboratory courses

| Question | Response % ¹ | |
|---|---|---|
| If you were concurrently enrolled in the laboratory and lecture was this course helpful in concurrently learning the content from lecture? | The lab has been helpful with the lecture. 97.4 (n=37) | The lab has not been helpful with the lecture. 2.6 (n=1) |
| If you were not currently enrolled in the lecture would this course have been helpful in concurrently learning the content from lecture when you had been enrolled? | Yes 100 (n=23) | No 0 (n=0) |

Note. ¹Surveys were administered online after student consent was given and students were not required to answer every question.

Of the students enrolled in the laboratory whom were enrolled in the lecture during a previous semester, 100% indicated the laboratory would have been helpful for their learning when they were enrolled in the lecture. Of students enrolled in the lecture alone, 88.24% indicated they wished they had enrolled in a laboratory section because they believed it would have improved their understanding of course concepts. Maiga and Bauer (2013) noted that

Table 3

Summative perception of students surveyed in 2022 in the animal reproduction lecture course about their beliefs towards the lecture and laboratory courses

| Question | Response % ¹ | |
|--|--|---|
| If you were not enrolled in the laboratory, would it have been helpful to have enrolled? | Yes 97.06 (n=66) | No 2.94 (n=2) |
| Why did you decide to take the laboratory? | I took it because it sounded interesting, but I was not required to take it. 71.05 (n=27) | I took it because I was required to. ² 28.95 (n=11) |
| If you did not take the laboratory which statement best matches your feelings? | I did not take it and had no interest in doing so. 11.76 (n=8) | I did not take it but wish that I would have. 88.24 (n=60) |

Note. ¹Surveys were administered online after student consent was given and students were not required to answer every question.

²Students at Kansas State University in the Animal Science and Industry undergraduate program who are the Biosciences degree option are required to take the animal reproduction laboratory.

when flash identification games were implemented as a learning tool in an animal reproduction course students felt the tool helped them study for exams, and a majority of students believed flash identification games helped them learn the course content. Student perceptions of their improved understanding of course concepts when

IMPACT OF ANIMAL REPRODUCTION LABORATORY

concurrently enrolled in lecture and laboratory sections in the present study are supported by the objective results of improved final lecture course percentages.

Summary

Concurrent enrollment in laboratory and lecture significantly improved final course percentages compared with students enrolled in lecture alone; the increase in course percentage for those enrolled in the laboratory demonstrates the benefits of hands-on learning. Students also perceived added benefits from the laboratory course as indicated by survey comments. Not only did taking the laboratory and lecture together empirically improve student final course percentages, but students also expressed the value they found in the hands-on learning opportunities provided in laboratory sections - an important consideration in evaluation of student satisfaction of their education. Students in the science option of the animal science major had a greater mean final course percentage than those in the production option. Students in the science option of the animal science major earning a greater final course percentage is not surprising, as they are required to take more science courses such as multiple semesters of chemistry and microbiology and thus likely develop a more robust foundational science knowledge. Students classified as juniors performed better than sophomores, suggesting that courses taken in their sophomore year prepare them for the animal reproduction course. In our study, gender did not significantly impact final student course percentages. The benefits of hands-on or experiential learning activities warrant providing students access to these activities and incorporating them in lecture courses when laboratory classes are unavailable to improve student performance and experiences. Our study highlighted the benefits of providing students with a laboratory course concurrently with an animal reproduction lecture.

References

- American Society of Animal Science. (2020). *Accreditation Standards for Animal Science Programs*. Retrieved December 19, 2024, from https://www.asas.org/docs/default-source/accreditation/accreditation-standards_8_1_22.pdf?sfvrsn=f3be52d1_2
- Bormann, J. M., Moser, D. W., & Bates, K. E. (2013). Factors affecting student performance in an undergraduate genetics course1. *Journal of Animal Science*, *91*(5), 2438–2443. <https://doi.org/10.2527/jas.2012-5839>
- Buchanan, D. S. (2008). ASAS Centennial Paper: Animal science teaching: A century of excellence. *Journal of Animal Science*, *86*(12), 3640–3646. <https://doi.org/10.2527/jas.2008-1366>
- Burk, S. V., Rossano, M. G., Silvia, W. J., Vanzant, E. S., Pescatore, A. J., & Harmon, R. J. (2013). Factors associated with course withdrawal and final course grade in an introductory animal science course. *NACTA Journal*, *57*(2), 16–23.
- Grizzle, J. M., Saxton, A. M., Snow, P., & Edmonds, C. (2008). A virtual laboratory for undergraduate instruction in domestic animal reproductive physiology: help or hindrance?. *NACTA Journal*, *52*(1), 49–54.
- Gucwa, K., & Cheng, H. (2014). RoboSim for integrated computing and STEM education. *2014 ASEE Annual Conference & Exposition Proceedings*, 24.1058.1-24.1058.17. <https://doi.org/10.18260/1-2--22991>
- Handur, V., Kalwad, P. D., Patil, M. S., Garagad, V. G., Yeligar, N., Pattar, P., Mehta, D., Baligar, P., & Joshi, G. H. (2016). Integrating class and laboratory with hands-on programming: its benefits and challenges. *2016 IEEE 4th International Conference on MOOCs, Innovation and Technology in Education (MITE)*, 163–168. <https://doi.org/10.1109/MITE.2016.041>
- Harris, D. E., Hannum, L., & Gupta, S. (2004). Contributing factors to student success in anatomy & physiology: lower outside workload & better preparation. *NACTA Journal*, *66*(3), 168–175.
- Haury, D. L., & Rillero, P. (1994). *Perspectives of hands-on science teaching*. ERIC Clearinghouse for Science, Mathematics and Environmental Education.
- Horvath, D. J., & Inskeep, E. K. (1968). Role of the laboratory in the teaching of animal science. *Journal of Animal Science*, *27*(Symposium), 952–955. <https://doi.org/10.1093/ansci/27.Symposium.952>
- Lancaster, S. H., & Robinson, J. S. (2011). Factors associated with student success in an introductory plant science course. *NACTA Journal*, *55*(2), 26–31.
- Lugar, D., Savage, N., & Stewart, K. (2023). Pre-Laboratory Material in a Flipped Animal Reproduction Laboratory: Student Performance and Perceptions. *NACTA Journal*, *66*(1). <https://doi.org/10.56103/nactaj.v66i1.68>
- Maiga, H. A., & Bauer, M. L. (2013). Using interactive flash games to enhance students' learning in animal sciences. *NACTA Journal*, *57*(3), 60–66.
- McMillan, M., Bullion, A., Stutts, K., Kelley, S., Beverly, M., & Rakowitz, L. (2009). Variables affecting final grade outcome in undergraduate-animal science courses. *NACTA Journal*, *53*(2), 29–33.
- Peffer, P. A. L. (2011). Demographics of an undergraduate animal sciences course and the influence of gender and major on course performance. *NACTA Journal*, *55*(1), 26–31.

IMPACT OF ANIMAL REPRODUCTION LABORATORY

- Poole, D. H., & Moore, J. A. (2016). Using review sessions to promote student learning in an animal reproduction course. *NACTA Journal*, *60*(2), 202–206.
- Pratt-Phillips, S., & Schmitt, S. (2009). The effect of previous experience on performance in an introductory-level undergraduate equine science class. *Journal of Equine Veterinary Science*, *29*(5), 450–451. <https://doi.org/10.1016/j.jevs.2009.04.145>
- Ragland, E. C., Radcliffe, S., & Karcher, E. L. (2023). A review of the application of active learning pedagogies in undergraduate animal science curricula. *Journal of Animal Science*, *101*, skac352. <https://doi.org/10.1093/jas/skac352>
- Roberts, G. (2006). A philosophical examination of experiential learning theory for agricultural educators. *Journal of Agricultural Education*, *47*(1), 17–29. <https://doi.org/10.5032/jae.2006.01017>
- Soberon, M. A., Cherney, D. J. R., & Kiely, R. C. (2012). Predictors of performance in an animal nutrition classroom. *NACTA Journal*, *56*(3), 6–9.
- Wells, K., VanLeeuwen, D., Seevers, B., White, L., & Cruces, L. (2019). Impact of traditional lecture and hands-on learning on students' knowledge gain in animal science courses. *NACTA Journal*, *63*(2), 319–321.
- Woiwode, R. (2016). 1747 Increase in demand for hands-on instruction in animal science curriculum. *Journal of Animal Science*, *94*(suppl_5), 851–851. <https://doi.org/10.2527/jam2016-1747>