

Grossed out to Engrossed: Experiential Learning Shifts Student Attitudes on Forensic Entomology

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Abstract: Students enrolled in forensic science programs at universities likely have preconceived ideas about crime investigations and protocols due to the influence of television shows, movies, or social media. A forensic field that is often overlooked is forensic entomology. Forensically relevant insects are sometimes a component of crime scene investigations, and most students have not had an opportunity to learn about them in an academic setting. Forensic Investigation (FI) at Purdue University includes a laboratory component and is one of the core courses required to obtain a minor in Forensic Sciences while Investigating Forensic Science (IFS) is lecture-only and not required to obtain the minor. Surveys inquiring about comfort levels with areas of forensic entomology, greatest challenges during the semester, and topics of most and least interest were distributed to FI students in Fall 2022 and 2023 semesters before and after any laboratory activities took place. Surveys were also distributed to IFS students, which learned about this topic through lecture and video. There was a significant positive change in comfort levels with forensic entomology after all laboratory activities in FI while there was no significant change in IFS student comfort levels. These results demonstrate the value of including forensic teaching models in the classroom and the impact of active learning in forensic science education. Experiential learning activities in forensic science education promote student engagement and can increase comfort levels around unfamiliar topics.

Keywords: CSI effect, active learning, forensic science, experiential learning, education

Introduction

Forensic science is undeniably embedded into American culture through the media and its popularization has influenced the perception of this scientific discipline (1). It is likely that those who are enrolled in forensic science college courses, either to fulfill a degree requirement or to pursue a career in the field, have already had some previous exposure to the topic through movies and shows, the news, or social media. With this media exposure, students may have preconceptions of what forensic science and crime scene investigation procedures entail, and what the protocols include.

Forensically relevant insects are often present during investigations, and many people have not previously learned about them in an academic setting. Blow fly larvae, better known as maggots, are an aspect of death investigations that people often view as disgusting, creepy, or bizarre (2,3). There are few accurate representations of forensic entomology in media, which limits the opportunity for people to gain exposure to forensic entomology through crime dramas. Depictions of this field often use other groups of insects that are not forensically relevant or show investigators quickly identifying insects and coming to conclusions at the scene

without any analysis. Inaccurate representations can lead to oversimplification and increased negative attitudes surrounding these insects.

Research has shown that exposure therapy for those who have entomophobia or arachnophobia can ease feelings of fear and disgust that is often associated with insects and spiders (3,4). Methods to desensitize individuals can include watching movies or reviewing images with spiders and insects, observing others having positive experiences, or by direct exposure (4,5). Those in roles such as crime scene investigators, law enforcement, or forensic technicians will encounter insects during their careers, so it is important to teach students enrolled in forensic science programs about their relevance. Exposing students to maggots, flies, and other insects in the lab can alleviate some of the discomfort and unfamiliarity that surrounds this field.

It can be challenging to design an activity that introduces forensic entomology to students for several reasons. There may be financial or ethical barriers for obtaining animals for forensic entomology teaching models. These activities also require outdoor space for preparing the models to ensure that students have specimens to collect, and there may be some discomfort from those who encounter the carcasses. Despite these challenges, forensic entomology is a valuable tool that

teaches students about ecological succession and insects associated with death investigations (6,7). Most students have not had experiences with applicable forensic examples, so hands-on laboratory activities create a memorable experience that students are more likely to retain and can apply in a future forensic career or other disciplines (8).

Forensic Investigation (ENTM 22810) at Purdue University provides an overview of crime scene investigation techniques, observation, collection and packaging of physical evidence. Since it represents most students' academic introduction to forensic science, it provides a unique opportunity to investigate initial attitudes, opinions, and prejudices for the subject. Furthermore, we can evaluate how lab experiences impact original impressions. The forensic entomology portion of the course takes place in a taphonomy module, where students receive lectures on decomposition, animal scavenging, recovering buried remains, and forensic entomology. In the forensic entomology active learning laboratory activity, students were asked to document their mock scene, assess decomposition of animal carcasses and collect different types of insect evidence. Students read literature about decomposition and insect evidence collection (9,10) before attending the laboratory, and they also complete an assignment on taphonomy during the week of the module.

Pre- and post- lab surveys were distributed to students at the beginning and end of the semester, before they had attended any of the labs and after the last lab. The goal for assessing the students was to learn the areas of forensic science in which they are most and least interested in, their challenges within the lab portion of the course, and how their comfort levels with forensic entomology shift after experiencing investigative techniques in the lab. Surveys were also distributed in Investigating Forensic Science (ENTM 12800), which is an introductory course that is lecture based, with no laboratory component. Students in both courses were surveyed to assess the impact of the experiential forensic entomology module in Forensic Investigation versus lectures on forensic entomology in Investigating Forensic Science on students' perceptions of forensic entomology. The proposed hypotheses are that comfort levels with forensic entomology will increase from the pre- to post-surveys for both courses, but there will be a greater increase in comfort in the course that includes a laboratory component (Forensic Investigation). Information gathered from the surveys will be to evaluate effectiveness of topics are covered in the curriculum and assist students with career paths of interest in forensic science.

Methods

To assess student perceptions of forensic entomology, surveys inquiring about topics of interest, comfort levels, and challenges were developed and distributed to students in Forensic Investigation (FI) during the Fall 2022 and Fall 2023 semesters. Surveys were also distributed to students in Investigating Forensic Science (IFS) during the Spring 2024 semester. These two courses were selected because they cover topics, and the main difference is that FI has a laboratory component, and IFS is lecture-only. Institutional Data Analytics and Assessment (IDA+A) provided deidentified demographics for students enrolled in the courses.

Course Information: Forensic Investigation (ENTM 22810)

Purdue University's Forensic Investigation course is a four-credit course with no prerequisites and represents one of the core courses required to obtain a minor in forensic sciences. A forensic sciences major is not offered at the university. This course has a large enrollment, 170 and 180 students during Fall 2022 and Fall 2023, respectively. The course includes two 75-minute lectures and one 3-hour laboratory per week, which are mostly face-to-face instruction with some virtual lectures. In each laboratory session, students work in small groups with a different area of forensic investigation each week, taking photographs, collecting and packaging evidence, and completing the associated documentation. This course includes labs on topics such as: crime scene documentation and sketching, crime scene reconstruction, fingerprints, footwear and toolmark impressions, blood spatter, presumptive testing, fire/arson, forensic entomology, and a summative lab practical with a mock crime scene.

Sample Population

The students that responded to the surveys in this study were enrolled in the course during either Fall 2022 or Fall 2023. The following demographics represent students who responded to at least one question and completed the pre-lab surveys, which was 94.3% of students enrolled in the course. The proportion of the sample population registered for the Forensic Sciences minor was 54.2%. The academic standing of the students is primarily sophomores (41.2%), followed by juniors (32.7%), seniors (20.3%), and freshmen (5.8%). Students from 9 colleges at the university were represented by the sample population (**FIGURE 1A**). The majority (55.4%) of students were in the College of Health and Human Sciences and Liberal Arts, and 48 majors offered by the university are represented by the sample population. Over 50% of students were majoring in Psychological Sciences,

Law and Society, or Cybersecurity (**FIGURE 1B**). Majors with 6 or fewer students (38 total majors) were categorized as “Other.”

- What area of forensic science interests you least?
- What do you think your biggest challenge was during the lab portion of this class?

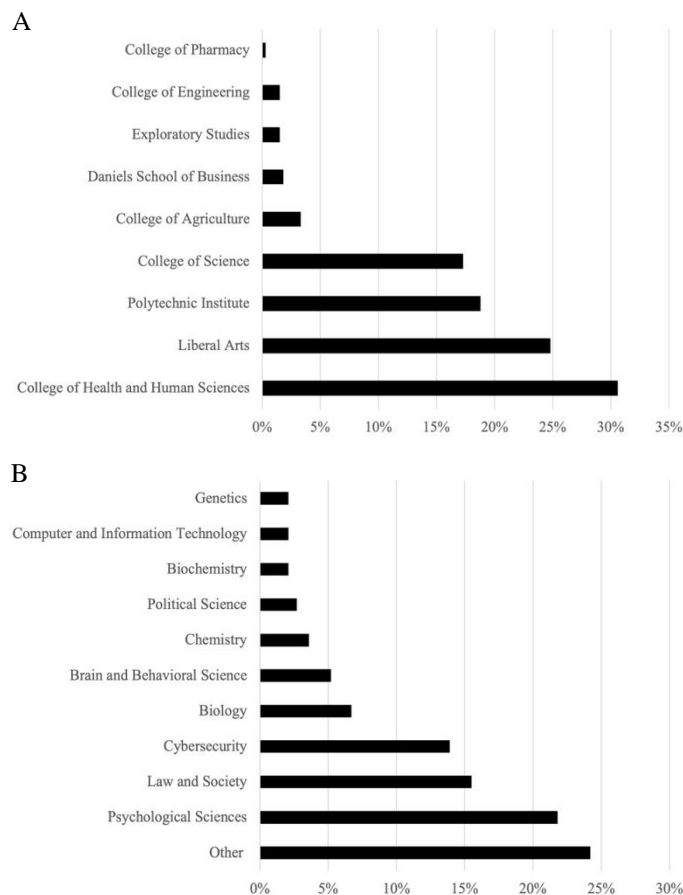


FIGURE 1 FI course composition during Fall 2022-23: A) College and B) Academic major.

Pre- and Post-Lab Surveys

Qualtrics XM was used to develop pre- and post-lab assessment surveys. The surveys consisted of 5-point Likert scale and open answer questions. The surveys were distributed through Desire 2 Learn (D2L) Brightspace, Purdue University’s learning management system. Completion of the survey was voluntary as the students did not receive any credit towards their course grade for participating, but the response rate was high. The students responded to the pre-lab survey during week 3 of the semester, which was the week of the first lab activity. The students responded to the post-lab survey during week 15, which was after they had completed the lab activities for all areas of forensic science covered in the course. The surveys asked the following questions:

- What area of forensic science interests you most?

Rate your comfort level with the following areas of forensic science.	Response options
Insect collection	Extremely
Maggot collection	Very
Decomposition smell	Moderately
Decomposition fluid	Somewhat
Death	Not

Forensic Entomology Activity

Stillborn pigs were obtained from the swine unit at Purdue University’s Animal Sciences Research and Education Center. The Forensic Entomology and Decomposition lab activity took place during week 7 and week 6 of the Fall 2022 and Fall 2023 semesters, respectively. The students received pigs in various stages of decomposition that were inside of a plastic bin containing around 2 inches of soil. The carcasses were prepared off-site before they were available for the students. The stages of decomposition that were available for students to work with were bloat, active, advanced, and skeletal remains. The laboratory sessions take place indoors, so preserved larvae, adult flies and adult beetles were added to all bins for students to collect and package. The live insects available for collection were dependent on the stage of decomposition. The students were tasked with properly collecting insect evidence from the pig and making observations about the stage of decomposition. Prior to the lab activity, students were given a brief lecture on how to collect insect evidence and the available collection materials.

Course Information: Investigating Forensic Science (ENTM 12800)

Purdue University’s Investigating Forensic Science course is a three-credit introductory course that has two 75-minute lectures per week that are mostly face-to-face with some virtual instruction. This course does not include a laboratory component, and registration is open to all students. This course introduces students to different areas of forensic investigation and analysis through different forms of media while also discussing errors and fraud that have arose in this discipline.

Sample Population

IFS also has a large enrollment, 109 students during Spring 2024. The proportion of the sample population registered for the Forensic Sciences minor was 13.8%. The academic standing of the students is primarily

freshmen (32%) and sophomores (30%), followed by juniors (22%), and seniors (16%). Students from 8 colleges and 36 majors at the university were represented in the sample population. The majority (77.1%) of students were in the Colleges of Science, Liberal Arts, or Health and Human Sciences (**FIGURE 2A**). Psychological Sciences and Law and Society were the most popular majors (**FIGURE 2B**). Majors with 2 or fewer students (26 total majors) were categorized as “Other.”

semester, respectively. The surveys asked the following questions:

- What area of forensic science interests you most?
- What area of forensic science interests you least?
- Rate your comfort level with the following areas of forensic science: insect collection, maggot collection, decomposition smell, decomposition fluid, and death.

Data and Analysis

We estimate and visualize potential effects of traditional and experiential learning classroom experiences on students’ reported comfort with specific aspects of forensic entomology using Mosaic plots and Bayesian cumulative probit regression models. Data analyzed are pre- and post-class ordinal responses to Likert-type survey questions about comfort with aspects of forensic entomology. The total population was split into two blocks by class type: those in traditional courses without a lab component (*no lab* condition; N=200 pre/post observations from N=100 students) and those in experiential learning courses with a lab component (*lab* condition; N=458 pre/post observations from N=229 students).

First, we describe the data using basic cross-tabulations of response distributions for each comfort item. Then, we use mosaic plots to visualize the relationship between comfort ratings and lab/no-lab conditions across pre/post surveys. Mosaic plots are more effective than scatterplots for visualizing bivariate relationships with ordinal variables; they are similar to heatmaps “except that the frequency of an observation... is proportional to the area of a tile” (11).

Next, Bayesian cumulative probit regression models are used estimate and visualize effects of classroom experiences students’ reported comfort. When analyzing ordinal items, cumulative probit models are superior to linear metric models (e.g., ANCOVA; OLS regression; see 12). One key advantage is that cumulative probit models allow the size of treatment effects to vary across the ordinal item’s response scale, which is particularly important for comfort ratings where, for example, the psychological distance between *not comfortable* and *somewhat comfortable* may differ from the distance between *very comfortable* and *extremely comfortable*.

Posterior distributions for model betas, predicted probabilities, and maximum contrasts are summarized in tables and plots with the median posterior density point estimate and 95% quantile intervals (credible intervals or CrI). All models showed good convergence based on R-hat statistics and effective sample sizes. A Bayesian approach offers several advantages over traditional null hypothesis significance testing (NHST) for this analysis. It provides direct probability statements about effects of

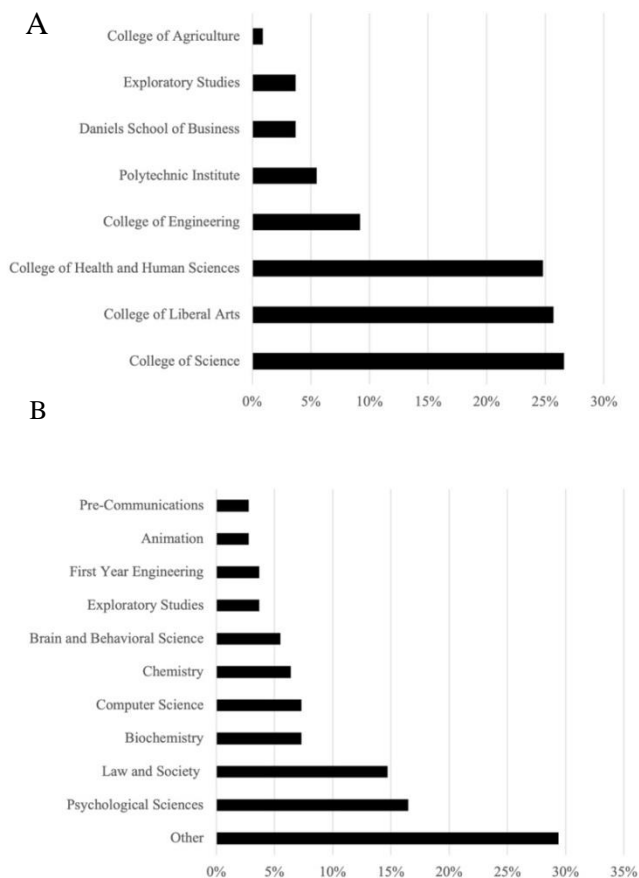


FIGURE 2 IFS course composition during Spring 2024: A) College and B) Academic major.

Pre- and Post-Course Surveys

Qualtrics XM was also used to develop pre- and post-course surveys, and they were administered using Desire 2 Learn (D2L) Brightspace. Students in this course received credit for completing each survey. The surveys consisted of 5-point Likert scale and open answer questions, and they were also not forced response, resulting in varying numbers of responses to the questions. Students learned about forensic entomology during week 8, and they responded to the pre- and post-course surveys during week 1 and 14 of the Spring 2024

interest (rather than *p*-values), naturally handles multiple comparisons without correction, and allows incorporation of uncertainty in both parameter estimates and derived quantities like predicted probabilities and contrasts. The posterior distributions also enable more nuanced interpretation of effects compared to binary significant/non-significant decisions.

We start with item-specific Bayesian cumulative probit regression models estimating effects of classroom experience (*post*=1), lab experience (*lab*=1), and their interaction (*post*lab*) each of the five ordinal comfort items. Models are specified with weakly informative prior distributions (Normal[0,1]) for covariate beta parameter coefficients and flat priors for the cumulative normal distribution thresholds to represent equal prior probabilities (=1/5 or 0.20) for each of the five item response categories. Each item-specific model is estimated with 4 chains and 2000 total post-warmup posterior draws per outcome using the `brms` (Bayesian regression models using Stan) R package (13). We then transform model effect estimates on latent scales into posterior predicted probabilities and probability contrasts using the `marginaleffects` R package (14). These item-specific model estimates are then transformed into posterior predicted probabilities, collapsed, and contrasted to estimate and plot classroom effects on the probability that the individuals in the lab component block will report a 4 (“very likely”) or a 5 (“extremely likely”) response to each ordinal comfort item.

After estimating item-specific models, we then fit a hierarchical Bayesian cumulative probit model that treats the five comfort items as repeated measures of a latent comfort construct. This multilevel approach allows for outcome-specific variation while borrowing strength across items through partial pooling. The model includes varying intercepts and slopes for the effect of classroom experience (*post*), lab condition (*lab*), and their interaction (*post*lab*) across comfort items. This model specifies the same weakly informative priors for fixed effects (Normal[0,1]) and flat priors for thresholds as in the item-specific models, with an additional exponential (1) prior on the standard deviation of random effects to induce appropriate shrinkage toward the population-level estimates. This hierarchical approach offers several advantages over separate item-specific models: (1) directly models the latent comfort construct while accounting for item-specific variation; (2) provides more efficient estimates through partial pooling of information across items; (3) appropriately handles the dependency structure of multiple comfort ratings from the same students; and (4) allows for estimation of both population-level effects on latent comfort and item-specific deviations. NVivo software was used to organize and analyze the open-answer responses by categorizing or “coding” themes mentioned by students. Coding the survey responses creates references for the themes within

the responses. We can see the number of responses that fit a particular theme and review similar responses in a list form.

IRB Information

This study was reviewed by the Purdue University Human Research Protection Program and qualified as exempt from IRB review (IRB number 2023-541).

Results: Comfort with Forensic Entomology Topics

In Forensic Investigation, the number of students who responded that they were not comfortable, somewhat comfortable, and moderately comfortable for all five topics decreased from the pre- to post-lab survey. Alternatively, the number of students who said that they were very comfortable or extremely comfortable for all five topics increased from the pre- to post-lab survey. The largest change from the pre- to post- lab survey was the percentage of students who said they were extremely comfortable with insect collection (16.6%).

In Investigating Forensic Science, the largest change from the pre- to post-course survey was in the number of students who said that they were not comfortable with maggot collection (-17%). Fewer students selected that they were not comfortable with maggot collection from the pre- to post- survey, and more students (+14.6%) selected that they were moderately comfortable with maggot collection. Maggot collection was the only topic with an increase in students who selected extremely comfortable. Death is the topic with the largest percentage of students who selected extremely comfortable (11.9%) during the post-lab survey. Overall, most of the changes in moderately and very comfortable categories are positive.

Cross-tabulations of response proportions

A preliminary examination of response proportions (TABLE 1) suggests differential effects of classroom experiences on student comfort across lab and no-lab conditions. For example, in insect collection, students in the lab condition showed substantial shifts toward higher comfort ratings (e.g., *extremely comfortable* increasing from 9.6% to 26.2%), while changes in the no-lab condition were modest. Similar patterns emerged across other forensic entomology aspects. While these raw proportions are informative, they represent single point estimates from our sample. We will extend to more sophisticated modeling approaches that will allow us to estimate and visualize our degree of uncertainty about the true population proportions and changes, accounting for the finite nature of our sample.

TABLE 1 Response proportions for comfort with forensic tasks (N=200 pre/post obs. from 100 students in “no lab” course; N= 458 pre/post obs. from 229 students in “lab” course).

Condition	Time	Not comfortable	Somewhat comfortable	Moderately comfortable	Very comfortable	Extremely comfortable
<i>Insect Collection</i>						
No Lab	Pre	0.320	0.270	0.210	0.130	0.070
No Lab	Post	0.210	0.280	0.290	0.150	0.070
Lab	Pre	0.205	0.201	0.284	0.214	0.096
Lab	Post	0.074	0.114	0.249	0.301	0.262
<i>Maggot Collection</i>						
No Lab	Pre	0.320	0.270	0.210	0.130	0.070
No Lab	Post	0.260	0.270	0.320	0.070	0.080
Lab	Pre	0.231	0.231	0.306	0.144	0.087
Lab	Post	0.114	0.100	0.258	0.288	0.240
<i>Decomposition Fluid</i>						
No Lab	Pre	0.270	0.190	0.330	0.150	0.060
No Lab	Post	0.180	0.270	0.330	0.170	0.050
Lab	Pre	0.175	0.266	0.336	0.148	0.074
Lab	Post	0.061	0.148	0.293	0.279	0.218
<i>Decomposition Smell</i>						
No Lab	Pre	0.220	0.380	0.250	0.100	0.050
No Lab	Post	0.230	0.260	0.340	0.120	0.050
Lab	Pre	0.175	0.262	0.297	0.201	0.066
Lab	Post	0.109	0.131	0.240	0.284	0.236
<i>Death</i>						
No Lab	Pre	0.090	0.160	0.340	0.300	0.110
No Lab	Post	0.090	0.120	0.340	0.330	0.120
Lab	Pre	0.087	0.179	0.371	0.210	0.153
Lab	Post	0.031	0.100	0.293	0.301	0.275

Item-specific Bayesian models predicting comfort outcomes

Results of item-specific Bayesian cumulative probit models help us estimate the magnitude of the classroom (post-pre) effect on each comfort outcome in courses with

and without a lab component. Full model coefficient summaries and posterior predictive checks are presented in the online supplement. Here, we extract from these models posterior estimates of the predicted probability

that students will report a “4” or a “5” (i.e., *very comfortable* or *extremely comfortable*) with each forensic aspect.

Students’ baseline comfort levels varied across forensic activities, with death-related aspects showing notably higher initial comfort ($P(\text{high comfort}) \approx 0.38\text{--}0.42$ at pre-test) compared to other activities ($P(\text{high comfort}) \approx 0.18\text{--}0.23$ at pre-test). The lab experience produced substantial increases in comfort across all activities. For insect collection, the lab condition increased the probability of high comfort by 0.30 [95% CrI: 0.22, 0.39], from 0.25 to 0.56, while the no-lab condition showed a smaller increase of 0.12 [0.04, 0.18]. Similar patterns emerged for maggot collection, where the lab experience produced a 0.29 [0.21, 0.37] increase in high comfort probability, compared to a modest 0.07 [-0.001, 0.13] increase in the no-lab condition. The effect of lab experience was particularly notable for decomposition fluid and smell: fluid comfort increased by 0.26 [0.17, 0.34] and smell comfort by 0.28 [0.20, 0.36] in the lab condition, while no-lab increases were minimal (0.04 [-0.03, 0.11] and 0.09 [0.01, 0.15] respectively). For death-related aspects, which showed higher baseline comfort, the lab condition still produced meaningful increases (0.16 [0.06, 0.26]) while comfort remained essentially unchanged in the no-lab condition (-0.002 [-0.10, 0.09]). All predicted probability and contrast estimates are reported in the online supplement in Tables S1 and S2, respectively; contrast estimates and 95% CrIs are displayed graphically in **FIGURE 3**.

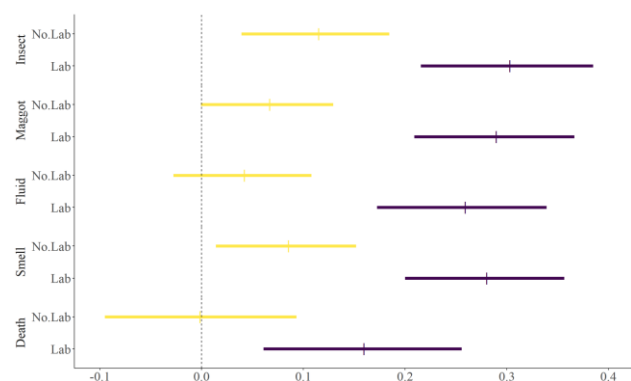


FIGURE 3 Effect of classroom experience (post-pre) on predicted probability of P (comfort ≥ 4).

Multilevel Bayesian model predicting latent comfort

After examining item-specific models, we fit a hierarchical model that treats the five comfort items as repeated measures of a latent comfort construct. This multilevel approach allows us to estimate overall changes

in comfort while accounting for item-specific variation through partial pooling. Full model coefficient summaries and posterior predictive checks are presented in the online supplement. Here, we extract population-level posterior estimates of response category probabilities and their contrasts across conditions.

Results from the hierarchical model estimating latent comfort reveal distinct patterns of change across response categories. In traditional (no-lab) courses, we found minimal changes in the probability of each response category from pre to post, with all contrasts centered near zero [-0.03, 0.02] and credibility intervals overlapping zero. However, the lab condition showed substantial shifts in response probabilities, with notable decreases in lower response categories (e.g., -0.12 [95% CrI: -0.17, -0.07] for *not comfortable* = 1; -0.09 [-0.12, -0.06] for *somewhat comfortable* = 2) and corresponding increases in higher categories (0.09 [0.05, 0.12] for *very comfortable* = 4; 0.15 [0.09, 0.21] for *extremely comfortable* = 5).

The predicted probabilities further illustrate this pattern: while response probabilities remained relatively stable in the no-lab condition, the lab condition showed a clear shift toward higher comfort ratings (**FIGURE 4**). For example, the probability of the highest comfort rating (*extremely comfortable* = 5) more than doubled in the lab condition (from 0.10 [0.05, 0.15] to 0.24 [0.16, 0.35]), while showing minimal change in the no-lab condition (0.07 [0.03, 0.12] to 0.08 [0.04, 0.14]). These latent model results align with and reinforce the patterns observed in the item-specific analyses, suggesting robust evidence that lab experiences substantially increase student comfort across forensic activities.

Results: Topics of Most Interest

Forensic Investigation

The topic that was mentioned most when FI students were asked what area of forensic science interests them most during the pre-lab survey was crime scene investigation (20%), followed by forensic psychology (19.7%), and cyber forensics (15.2%) (**TABLE 2**). For the post-lab survey, the topics mentioned most frequently stayed the same but had slight changes in percentages. The topic that had the greatest change from the pre- to post-lab surveys was forensic pathology. Many students mentioned more than one topic of interest, so these results are presented as the percentage of responses that mentioned each topic. The topics included in Table 2 were mentioned at least 8 times in either the pre- (n=335) or post-lab (n=255) survey responses.

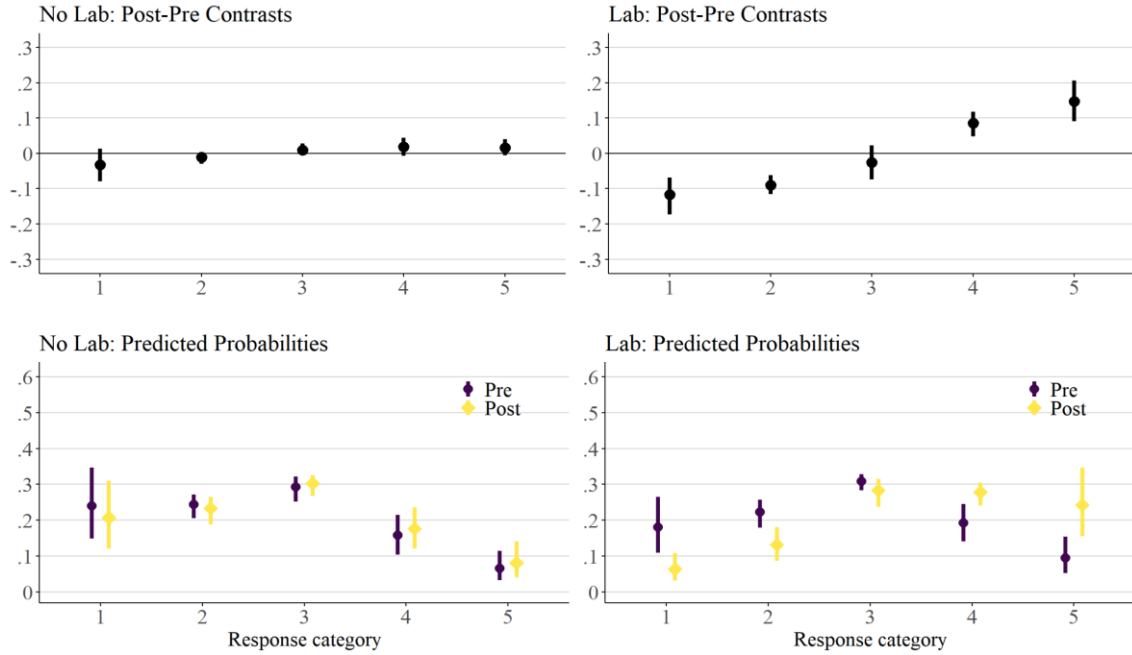


FIGURE 4 Predicted probabilities (bottom) and effects of classroom experiences (post–pre differences in probabilities; top) on latent comfort response categories, by no lab (left) or lab (right) condition.

TABLE 2 Percentage of responses that mentioned each topic when FI students were asked what topic interests them most.

Area of most interest	Pre	Post	Change
Fingerprints	2.4%	5.9%	+3.5%
Criminology	1.5%	4.3%	+2.8%
Bloodstain pattern analysis	2.1%	3.5%	+1.4%
Cyber forensics	15.2%	16.5%	+1.3%
Biology/DNA	7.8%	8.6%	+0.8%
Chemistry	3.3%	3.9%	+0.6%
Forensic analysis	5.1%	5.5%	+0.4%
Toxicology	4.2%	3.9%	-0.3%
Ballistics/Firearms	2.7%	2%	-0.7%
Entomology	3.6%	2.7%	-0.9%
Anthropology	4.2%	2.2%	-2%
Crime scene investigation	20%	17.3%	-2.7%
Pathology	6.3%	2.4%	-3.9%
Psychology	19.7%	15.7%	-4%

The topics that were mentioned by IFS students most frequently in both the pre- and post-course surveys were crime scene investigation and forensic psychology (TABLE 3). However, crime scene investigation was the category that had the largest change (-7%) except for the “unsure” category. The topics included in TABLE 3 were mentioned at least 5 times in either the pre- (n=110) or post-lab (n=101) survey responses.

TABLE 3 Percentage of responses that mentioned each topic when IFS students were asked what topic interests them most.

Area of most interest	Pre	Post	Change
Psychology	25.5%	31.7%	+6.2%
Chemistry	6.4%	11.9%	+5.5%
Anthropology	2.7%	6.9%	+4.2%
Fingerprints	7.3%	8.9%	+1.6%
Ballistics/Firearms	6.4%	5.9%	-0.5%
Biology/DNA	4.5%	4%	-0.5%
Toxicology	10%	8.9%	-1.1%
Pathology	5.5%	2%	-3.5%
Crime scene investigation	20.9%	13.9%	-7%
Unsure	7.3%	0%	-7.3%

Results: Topics of Least Interest
Forensic Investigation

The topics that were mentioned most frequently when students were asked what area of forensic science interests them least in both surveys were forensic entomology and cyber forensics (TABLE 4). Of the post lab survey responses, 30.2% of FI students mentioned entomology as their topic of least interest, whereas 15.9% of students said that they did not have a topic of least interest during the pre-lab survey, and 9% of students selected this during the post-lab survey. The topics included in Table 4 were mentioned at least 7 times in either the pre- (n=170) or post- (n=255) lab survey responses.

TABLE 4 *Percentage of responses that mentioned each topic when FI students were asked what topic interests them least.*

Area of least interest	Pre	Post	Change
Anthropology	1.8%	5.5%	+3.7%
Decomposition	1.2%	4.7%	+3.5%
Bloodstain pattern analysis	0.6%	2.7%	+2.1%
Entomology	29.4%	30.2%	+0.8%
Ballistics/Firearms	4.1%	3.5%	-0.6%
Cyber forensics	12.4%	11.8%	-0.6%
Documentation	5.9%	5.1%	-0.8%
Unsure	7.1%	3.1%	-4%
None	15.9%	9%	-6.9%

Investigating Forensic Science

Forensic entomology was mentioned most frequently in both the pre- and post-course survey responses and had the largest change (+9.6%) other than the “unsure” category (TABLE 5). For the post- course survey, 39.6 % of students mentioned entomology whereas the next frequently mentioned topic of least interest was ballistics/firearm analysis at only 11.9%. There was also a large positive increase (+9.2%) in the percentage of students who mentioned ballistics/firearms analysis. The topics included in Table 5 were mentioned at least 4 times in either the pre- (n=110) or post- (n=101) lab survey responses.

TABLE 5 *Percentages of responses that mentioned each topic when IFS students were asked what topic interests them least.*

Area of least interest	Pre	Post	Change
Entomology	30%	39.6%	+9.6%
Ballistics/Firearms	2.7%	11.9%	+9.2%
Pathology	0%	6.9%	+6.9%
Odontology	2.7%	5.9%	+3.2%
Impression evidence	1.8%	4%	+1.2%
Accounting	3.6%	4%	+0.4%
Anthropology	3.6%	4%	+0.4%
None	3.6%	4%	+0.4%
Cyber forensics	3.6%	1%	-2.6%
Biology/DNA	3.6%	0%	-3.6%
Decomposition	12.7%	5%	-7.7%
Unsure	13.6%	2%	-11.6%

Results: Greatest Challenges (FI)

The most frequently mentioned challenge (23.5%) of the semester was completing the proper documentation associated with the lab activity, followed by packaging (10.2%), and working in a group (9.4%) (TABLE 6). Around 20% of students mentioned that working with a dead animal, decomposition, insects, or a combination of these elements was their greatest challenge during the lab portion of the course. One student reflected, “My biggest challenge was working with the dead pigs and learning what decomposition smells like.” Topics that were mentioned at least 10 times in the post-lab survey responses can be found in TABLE 6.

TABLE 6 Percentage of responses that mentioned each topic when FI students were asked about their greatest challenge (n=255).

Greatest Challenge	Occurrence in responses
Documentation	23.5%
Packaging	10.2%
Group Work	9.4%
Entomology	9%
Decomposition (odor)	7.5%
Protocols	7.5%
Time management	6.3%
Crime scene sketching	5.9%
Working around remains	4.3%
Detail	3.9%
Mock crime lab	3.9%
None	3.9%

Discussion

The results of this study indicate that forensic entomology remains a topic that causes unease, but most students are able to overcome this and recognize its importance in forensic investigations. There was an increase in percentage of FI students who selected very or extremely comfortable and a decrease in students who selected moderately, somewhat, or not comfortable for all forensic entomology topics. There is no similar trend in the IFS responses, and there was minimal increase in comfort for most of the topics from the pre- to post survey. Students in the FI course were overall more comfortable with forensic entomology topics, compared to IFS students, both before and after taking the course. One possible explanation for this is that 54.2% of these students are enrolled in the Forensic Sciences minor, compared to only 13.8% of students in IFS. These differences are also likely due to FI students having the opportunity to experience insects and decomposition in a controlled academic environment while IFS students learned about this topic through lectures, photos, and videos. Though there is evidence that photos and videos can alleviate some discomfort associated with insects and spiders (5), the contrasting survey responses between the two courses in this study demonstrate that direct exposure and interaction with the insects can result in a large positive shift in comfort levels.

The leading topics of interest are crime scene investigation and psychological sciences, which is supported by the topic of interest results (**TABLES 2 AND 3**) as well as psychological sciences being the most popular major among students in both courses (**FIGURES**

1B AND 2B). The percentage of students who mentioned crime scene investigation in their topic of most interest response decreased from the pre- to post- survey in both courses (**TABLES 2 AND 3**). This indicates that students were either previously unaware of what crime scene investigation protocols entail, or that students were able to gain a better understanding of their interests and career goals through learning about many career paths in forensic science during the course.

Forensic entomology was the most frequently mentioned topic when students in both courses were asked which topic interests them least, and the percentage of responses mentioning entomology increased from the pre- to post- survey for both courses. More students, in both courses, were disinterested in forensic entomology after taking the course. This result contrasts a study where 185.7% more of survey responses included entomology when students were asked to identify their top three forensic disciplines after taking an Introduction to Forensic Science course (15). Similar to this study, Buffalini et al. (2022) reported that forensic entomology as a suggested elective course is of low student interest. Forensic entomology is a relatively small discipline when compared to other forensic sciences, so it is no surprise that most students are interested in other topics more than entomology (16).

The challenges mentioned most frequently by FI students were crime scene documentation and packaging evidence. This was an expected result as it is often mentioned by students throughout the semester. Students reported that it was a tedious task, but they understand why it is necessary. One student wrote:

“I think my biggest challenge was all the paperwork that goes along with it, though I understand its importance and necessity.”

Whereas another commented:

“[My biggest challenge was] making sure that I had all of the information filled out correctly on the forms and packaging evidence.”

Many student responses mentioned two or more aspects of the forensic entomology and decomposition lab activity as their greatest challenge, so it is difficult to narrow down which specific element has the largest impact on students. The reasons why people have an aversion to forensic entomology and decomposition are often complex and difficult to generalize. Some students did not have any issue with decomposition or working with animal remains, and it was the maggots and other insects that were a challenge. On the other hand, the maggots and insects did not affect some students as much as working with animal remains and decomposition. These results imply that it is usually not just one factor alone, whether that is insects, maggots, animal remains, or

decomposition, that cause a negative response to the field of forensic entomology, but a combination of these elements that can be unique to one's own experience. This sentiment is represented by the following student comments:

"I think the biggest challenge for me was seeing the dead piglet during the decomposition lab. I grew up on a farm, so I have a hard time seeing animals like that."

"I think the biggest challenge was the entomology lab. I could handle the decomposing pig and smell of decomposition; however, the maggots and other bugs freaked me out."

"The maggot collection was also a difficult task since the odor made me nauseous. However, by the final lab, I was used to bad odors and could successfully collect insects."

The two courses included in this study cover similar information but have different course structures. Students in FI had the opportunity to actively work with insects and decomposition in the laboratory while IFS students learned about this topic through lectures and an assignment. The differing results between the students in the two courses demonstrate that experiential learning in a laboratory setting can have a positive influence on students' ability to learn about an unappealing topic. McNeil (2010) and the results of this study show that students' attitudes towards forensic entomology may depend on how it is presented to them, so the modality of the information should be considered when interpreting survey results (7). Experiential learning activities change the way that students think about a topic from that moment forward, which contrasts traditional lecture (17). Through Forensic entomology teaching models have been used as a

experiential learning activities, students can make connections to previous experiences and apply the new information to other real-world scenarios or scientific disciplines.

This study was conducted to learn what topics interest forensic science students most and least, their challenges during the semester, and to assess if students can become more comfortable with forensic entomology after experiencing a hands-on teaching model in the laboratory. Forensic entomology teaching models have been used as a tool to teach students about decomposition, ecological succession, forensically relevant insects, and other related scientific concepts (6,7). Students enrolled in forensic science courses usually have previous exposure to areas of forensic investigation through the media, which can lead to students pursuing a degree and having a false sense of their career goals due to inaccurate depictions of the field. Having forensic teaching models available for students can bridge the knowledge gap that is often created when television shows and other media are their only point of reference.

There is minimal literature on student learning in forensic science and few scholarship of teaching and learning studies mention forensic entomology at all. This study and others have shown varying results in terms of interest and comfort with forensic entomology (15,16) Given that insects can be useful evidence at death investigations, more research is needed on students enrolled in forensic science courses to gain an understanding of best practices when introducing students to this topic. It would be beneficial for educators who teach taphonomy modules in their courses to survey their students regarding their feelings and attitudes towards the topic, and it may encourage other forensic science educators to include a similar activity in their courses.

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Supplemental Information

https://reluctantcriminologists.com/supp/chb-supp/os/chb_sotl

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