2015

FORS 401: Forensic Biochemistry—A Peer Review of Teaching Project Inquiry Portfolio

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Peer Review of Teaching Inquiry Portfolio

Course: Forensic Biochemistry (FORS 401)

Spring 2015

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Introduction

The goal of the activities described in this inquiry portfolio was to improve content delivery by using the popular media as a learning tool in Forensic Biochemistry (FORS 401), an upper level course required for majors in the biochemistry track of the undergraduate Forensic Science Degree Program.

The course objectives are:

1. Demonstrate scientific reasoning; the application of the scientific method
2. Recognize the connection between basic and applied science as demonstrated by the integration of the theory and practice of forensic science
3. Understand the theory and application of body fluid identification
4. Demonstrate an understanding of the theory and practice of DNA analysis in a forensic context
5. Discuss the regulatory guidelines of forensic DNA analysis

In FORS 401, students are introduced to the theory and practice of forensic biochemistry (body fluid identification and DNA analysis). They are guided through the history, from early techniques for body fluid identification (serology) and the detection of protein polymorphisms to the DNA profiling technologies currently employed in operational U.S. crime laboratories. The basic scientific principles underlying the applied methods used in the analysis of forensic biological samples are presented. Students are also introduced to advanced topics in forensic biochemistry, and learn the vocabulary that will allow them to interact with other forensic scientists in an intelligent and meaningful way.

Problem to Investigate: Can forensic science in the popular media be used as a teaching tool?

History. I have taught Forensic Biochemistry every spring from 2011 to 2015. For the first two years, I delivered the material by lecture and assessed student performance with a mid-term and final exam. Although I demonstrated techniques such as DNA typing, the students' participation was passive and did not include hands-on activities. By the third time I taught the class (2013), I began to experiment with different learning techniques, developing a benchmark portfolio as part of the Peer Review of Teaching Program. In that study, I evaluated the effects of incorporating active and experiential learning exercises into my curriculum rather than relying solely on traditional lecture-and-test methods. I incorporated group activities and hands-on exercises focused on the interpretation of forensic serological and DNA evidence into the curriculum to reinforce principles presented in class.

Student understanding of the material was assessed using exam questions duplicated from previous years. A comparison of the average scores from each year provided an evaluation of student comprehension of material presented with different pedagogical approaches. The scores for the exam questions relating directly to these topics improved significantly from an class average score of 30% correct in 2011 (lecture only) to 70% correct in 2013 (active and experiential).

Student perception of understanding was also an important consideration. To provide a measure of the confidence gained over the course of the term, students completed a pre- and post- semester self-assessment questionnaire. Questions were designed to evaluate understanding of a number of topics including body fluid identification and DNA analysis. There was an approximate 40% increase in self-reported understanding of these critical topics, indicating success in the use of active and experiential learning methods.

Significance. An in-depth understanding of the basic principles and methods in forensic biochemistry is critical to student success in advanced courses in the program, and later in their professional careers. FORS 401 is the first of a three course arc that is the cornerstone of the Forensic Biochemistry option of the undergraduate degree program. In the second class, Forensic Y-STR Analysis (FORS 408), the theory and practice of advanced DNA analysis techniques are presented, relying heavily on student understanding of the basic science developed during FORS 401. In the final Capstone course (FORS 485), students are expected to perform body fluid identification and DNA analysis methods learned in the previous two courses with minimal involvement of the instructor. During the course, students participate in a mock crime investigation. They perform body fluid identification and DNA profiling as crime lab analysts, and present their results as expert witnesses in a mock trial presided over by a sitting judge and involving senior law school students as prosecution and defense. Therefore, by this stage in their academic careers, it is important that students are comfortable with both the theory and practice of forensic biochemistry. A solid foundation in FORS 401 is critical to support ultimate student success in the upper level forensic science courses.

The next question. While the incorporation of in-class activities resulted in a marked improvement to exam scores in 2013, the grades were still average on the A-to-F scale (~70%). In subsequent years, I began to ask if there were better ways to facilitate student understanding of the theory and practice of forensic biochemistry. In the newly-introduced group activities of 2013, students typed DNA samples, read and discussed articles, and held group discussions on various current topics in forensic science. While this approach was more successful than a lecture/test format, it didn't appear to engage and excite the students; they were focusing on learning the material that would be on the test, rather than developing a true understanding.

In developing better methods to promote active learning, I considered the characteristics of the average college-age students I've observed at the university. One common accessory amongst the group was the ever-present media, both social and popular (entertainment). In fact, the majority of students in my classes report watching at least one of the many popular forensic science shows on TV. Therefore, I hypothesized that this media could be a learning tool to enhance student understanding of scientific concepts. Students were already engaged in the format, and I wanted to further use the medium to foster excitement and increase active participation in the classroom processes.

Methodology for Investigation

Popular Media. There are both good and bad examples of the practice of forensic science in popular television shows. For this study, I based classroom exercises on the screenings of two shows - "The New Detectives" (A&E) and "CSI: Crime Scene Investigation" (CBS). The former is a documentary-style presentation that represents the practice of forensic science accurately, including interviews with investigators and lab personnel involved in a true case ("good" media). CSI: Crime Scene Investigation is a more sensationalized version of the practice of forensic science designed to entertain that, in many cases, is not true-to-life ("bad" media). Learning assessments were designed to explore two questions: 1) does the use of popular media in the classroom increase student understanding?; and 2) does the use of "good" vs "bad" media examples impact student understanding?

To answer the first question, I considered the course in halves, divided by the mid-term exam. Forensic serology was the focus of the first half of the course, and DNA analysis was the core of the second. In the first half of the course, I incorporated the TV shows into my lessons. Students were instructed to take notes during the screening of the shows, recording any serological techniques they observed and assessing the validity of what was presented. We discussed their observations at length in a subsequent

class discussion to reinforce the material. Popular media was not used as a learning tool in the DNA analysis portion of the course.

To answer the second question, I focused on the lessons involving blood and semen identification. I used "good" media to support the presentation of the former, but involved only "bad" media in the discussions of the latter. Episodes of "The New Detectives" involving the forensic identification of blood were carefully selected and shown to the class. In discussion that followed, I included reference to the techniques, the basic science, and investigative techniques. I played an episode of "CSI: Crime Scene Investigation" for the students while teaching the module on semen identification. In this case, students described the faulty science they observed throughout the show, and suggested how it could have been improved upon. Equal amounts of class time were spent discussing each technique, only the quality of the media supporting each differed.

Assessments.

Student Self-Assessment Questionnaire

An effective tool for measuring a student's perception of his/her progress over the course of a semester was a self-assessment questionnaire, given at the start and finish of the semester. Forensic Biochemistry students were asked to use a two-word moniker, other than their names, to identify their survey. By using the same descriptor in pre- and post-semester questionnaires, the answers could be compared while anonymity was preserved. Students completed a fourteen-question survey in which they were asked to rate their understanding of different subjects on a scale of 1 (none) to 5 (expert). Three of the fourteen questions specifically addressed the understanding of serology and DNA analysis. To evaluate the responses, the pre-semester values were subtracted from the post-semester values; Table 1 (**Appendix 3**) summarizes the data. Values recorded by each student in the pre-and post-semester

questionnaires are listed. The change in value (Δ) is calculated, and Δ values from students' 2013 questionnaires are included for comparison.

Exam Questions

Exam questions were designed to assess student understanding of the basic principles of forensic serology (mid-term) and DNA profiling (final). In the serology section, students were asked to identify the common pathways involved in blood and semen identification. This required them to not only know the specific tests, but also to generalize the underlying scientific principles. For example, one of the components of blood participates in a reduction-oxidation reaction that results in the change in the color of a substrate from clear to pink or green. On the final, students were given DNA profiling results, asked to determine the genotype and interpret the results, requiring them to associate the theory with the practice.

Potential Problems: Seven students were enrolled in FORS 401 in the spring of 2015. While conclusions could be drawn based upon this data set, significant statistical analyses could not be performed. In future offerings of the course, additional information will be collected and added to this data set.

Analysis and Assessment of Findings

Student Self-Assessment Survey:

Three questions on the pre-and post-semester confidence survey related directly to an understanding of the basic principles of forensic serology and DNA analysis. The data is summarized in Table 1 (**Appendix 3**). To convert loss or gain of points to percentage, the pre-survey values were subtracted from the post-survey ones. The resulting value was divided by 5 (the number of points possible) and multiplied by 100. Results are shown for the 2013 and 2015 classes. The only difference between the two courses was the addition of popular media as a teaching tool in 2015.

- *Question: How would you rate your understanding of **forensic science in general**? (1 = none, 5 = expert)*

  2015: 14% increase from pre-survey

  2013: 6% increase from pre-survey

- *Question: How would you rate your understanding of **forensic body fluid identification**? (1 = none, 5 = expert)*

  2015: 51% increase from pre-survey

  2013: 34% increase from pre-survey

- *Question: How would you rate your understanding of **forensic DNA analysis**? (1 = none, 5 = expert)*

  2015: 37% increase from pre-survey

2013: 34% increase from pre-survey

Student self-confidence increased significantly in the areas of general forensic science and body fluid identification. The popular media was used to complement traditional teaching methods and established group activities specifically in these areas. No other changes were made to the course material or teaching style, therefore this data supports the hypothesis that the popular media can be a learning tool to enhance student understanding of scientific concepts.

Exam Questions

On the mid-term exam, I posed two questions designed to assess student understanding of forensic serology. The first focused specifically on the pathway common to blood identification and the second tested knowledge of the mechanisms of semen identification. During class, I used "good" media to support the presentation of the former (screening episodes of "The New Detectives"), but involved only "bad" media in the discussions of the latter (in the form of episodes of "CSI: Crime Scene Investigation"). On the mid-term exam, the student average for the blood ID question was 94%, while responses to the semen ID question only averaged 82%. The final exam contained a question designed to evaluate understanding of DNA profiling. The (2015) class average was 72%, compared to a 2013 class average of 70%. These results generally agree with those generated from the student self-assessment.

The hypothesis tested in this study was: popular media can be a learning tool in the classroom to enhance student understanding of scientific concepts. To further define this broad question, I asked: 1) does the use of popular media in the classroom increase student understanding?; and 2) does the use of "good" vs "bad" media examples impact student understanding? The results support the hypothesis. Both student confidence and performance on exams was greater in the areas in which media sources were used to reinforce basic concepts. Further, presenting "good" media had a greater impact than the

use of “bad” media. Incorporating the media into the course framework was successful. Students were more engaged during class and actively participated in discussions. These results suggest that efforts should be made to use the media as a learning tool in all subjects in the forensic science classroom.

Appendix 1. FORS 401 Syllabus

FORENSIC BIOCHEMISTRY
FORS 401
Spring 2015

Section: 001

Credits: 3

Class Time: T Tr 9:30 – 10:45 am

Location: Entomology Hall, 110

Instructor: Dr. Ashley Hall
ashleyhall@unl.edu
402-472-6556

Office Hours: By Appointment
215 Entomology Hall

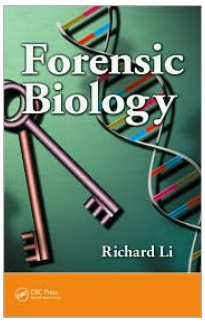
Course Description: This course introduces students to the theory and practice of forensic biology (serology and DNA analysis). It forms a foundation for more advanced studies in the fields of forensic biochemistry and population genetics. Students are introduced to techniques that are currently, or have been previously, used in operational crime laboratories in the U.S.

Prerequisites: Required: BIOS 102 or LIFE 120, BIOS 205/206 or AGRO 315, FORS 120/120L
Suggested: BIOS 443, BIOS 303

Objectives: After taking this course, students will:

1. Demonstrate scientific reasoning; the application of the scientific method
2. Recognize the connection between basic and applied science as demonstrated by the integration of the theory and practice of forensic science
3. Understand the theory and application of body fluid identification
4. Demonstrate an understanding of the theory and practice of DNA analysis in a forensic context
5. Discuss the regulatory guidelines of forensic DNA analysis

Text: Forensic Biology by Richard Li
1st Edition
Hardcover: 448 pages
Publisher: CRC Press, Boca Raton FL
ISBN-10: 1420043439
ISBN-13: 978-1420043433



Withdrawal Deadline: April 10, 2015

Supplemental: Readings in the fields of Forensic Serology/DNA analysis will be provided

Attendance Policy: Attendance is **required** since some exam topics may be presented during class discussions and PowerPoint presentations that are not included in the text.

Grading: *You will be assigned one grade for Forensic Biochemistry (FORS 401/401L).* The lecture portion of Forensic Biochemistry will account for 80% of your final grade. The lab portion will account for the remaining 20% (see separate lab syllabus for details of grading in that portion).

The lecture grade will be based upon:

Mid-term exam	100 points
Final Exam	100 points
Project	50 points
In-class Activities (3 x 20 points)	60 points
TOTAL	310 points

Note: the final exam is mandatory and graduating seniors will not be excused from final exams or any other course requirement.

Grading Scale: A (90 – 100); B (80 – 89.99); C (70 – 79.99); D (60 – 69.99); F (59.99 and below)

Make-Up Policy: There will be **NO** make-up exams offered either before the class date or after. Please plan your schedule accordingly.

Students with Disabilities:

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

CASNR Policy on Academic Dishonesty:

All students and faculty should be familiar with the UNL Policy regarding Academic Dishonesty that maybe found in the Student Code of Conduct http://stuafs.unl.edu/ja/code/three.shtml

When a student is notified by an instructor of an alleged act of Academic Dishonesty, (s)he should discuss the matter with the instructor to determine if redress is possible. If the instructor decides to move forward with the allegation of Academic Dishonesty and the result is a lower grade, the instructor shall make a report in writing of the facts of the case and the academic sanction imposed against the student to the instructor's Department Chair or Head and to the UNL Judicial Officer. Both the instructor and the Department should maintain copies of the relevant documents on file for at least two years. If the student feels that the allegations of the instructor regarding Academic Dishonesty, or the proposed penalty to be imposed, are unjust or not warranted, the student should contact their academic advisor and the Department/Program Chair/Head/Director to discuss the matter. This process must be initiated within one month of the class grade assignment. The Department/Program should then initiate a revue of the matter consistent with its written policy. If the Department/Program agrees with the Instructor that the evidence indicates that the student has violated the Academic Dishonesty policy, they should forward the documentation and paperwork to the CASNR Associate Dean for Student Affairs for review by the College. If the Department/Program determines that there is not sufficient evidence of Academic Dishonesty to warrant action against the student, the paperwork should be forwarded to the CASNR Dean with the student's name deleted so that there is a record of the incident, but no potential future bias toward the student. Once received by the CASNR Associate Dean for Student Affairs, the file alleging student Academic Dishonesty should be considered by a Panel consisting of the CASNR Associate/Assistant Deans. If the Panel decides that there is sufficient evidence to support the allegation of Academic Dishonesty made by the instructor, the student will be notified. If the student desires to appeal this decision, the file will be forwarded to the CASNR Dean for transfer to the UNL Judicial Officer.

Blackboard:

Various student resources are available for any issues you experience with Blackboard® courseware and any other technical problems that might arise during the course of the semester. You can find a list of helpful resources under "Online Help Resources" on the "My UNL" Blackboard page.

UNL Blackboard Help Desk
Phone: (402) 472-3970
E-mail: helpdesk@unl.edu

Emergency Response:

- **Fire Alarm (or other evacuation):** In the event of a fire alarm: Gather belongings (Purse, keys, cellphone, N-Card, etc.) and use the nearest exit to leave the building. Do not use the elevators. After exiting notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.
- **Tornado Warning:** When sirens sound, move to the lowest interior area of building or designated shelter**.** Stay away from windows and stay near an inside wall when possible.
- **Active Shooter**
  - **Evacuate:** if there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.
  - **Hide out:** If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.
  - **Take action**: As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.
- **UNL Alert:** Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: http://unlalert.unl.edu.
- Additional Emergency Procedures can be found here: http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf

Class Schedule

Week	Topic	Reading
1 Jan-13 & Jan-15	Intro and philosophy of forensic biochemistry Forensic Serology Basics	CH 1, 2, 3 CH 4, CH 5
2 Jan-20 & Jan-22	Serology Basics Blood ID	CH 4, CH 5 CH 6
3 Jan-27 & Jan-29	Blood ID Species ID	CH 6 CH 7
4 Feb-3 & Feb-5	Identification of Semen	CH 8
5 Feb-10 & Feb-12	Identification of Saliva and Other Biological Fluids	CH 9
6 Feb-17 & Feb-19	Blood Group Typing and Protein Profiling	CH 10
7 Feb-24 & Feb-26	**In-Class Activity 1** **Mid-term Exam (CH 1 – 10 and supplemental material)**	**2/26/2015**
8 Mar-3 & Mar-5	DNA Structure and Function	CH 11
9 Mar-10 & Mar-12	DNA Extraction/Quantification	CH 12, CH 13, 15
10 Mar-17 & Mar-19	DNA Profiling	CH 14, 17, 18, 20
11 Mar-24 & Mar-26	SPRING BREAK	
12 Mar-31 & Apr-2	DNA Profiling Lineage Markers	CH 14, 17, 18, 20 CH 19, 20 & 21
13 Apr-7 & Apr-9	Lineage Markers **In-Class Activity 2**	CH 19, 20 & 21
14	Population Genetics	CH 23

Apr-14 & Apr-16		
15 Apr-21 & Apr-23	Databases/Quality Assurance	CH 22 & 24
16 Apr-28 & Apr-30	**In-Class Activity 3**	
5-May	**Final Exam (CH 1 -23 and supplemental)** **http://registrar.unl.edu/final-exam-information-spring**	10:00 am - 12:00 am, ENTO 110

Note: This schedule is subject to change.

Appendix 2. Student Self-Assessment Questionnaire

Identifier:

Circle the classes you have taken:

Biochemistry

Biochemistry lab

Genetics

Genetics lab

Molecular biology

Immunology

Statistics

How would you rate your understanding of molecular biology? (1 = none, 5 = expert)

1 2 3 4 5

How would you rate your understanding of biochemistry? (1 = none, 5 = expert)

1 2 3 4 5

How would you rate your understanding of genetics? (1 = none, 5 = expert)

1 2 3 4 5

How would you rate your ability to apply scientific reasoning to a problem, i.e. the scientific method? (1 = none, 5 = expert)

1 2 3 4 5

How would you rate your understanding of how basic and applied science are related? ((1 = none, 5 = expert)

1 2 3 4 5

How would you rate your understanding of forensic science in general? (1 = none, 5 = expert)

1 2 3 4 5

How would you rate your understanding of forensic body fluid identification? (1 = none, 5 = expert)

1 2 3 4 5

How would you rate your understanding of forensic DNA analysis? (1 = none, 5 = expert)

1 2 3 4 5

How would you rate your understanding of quality assurance? (1 = none, 5 = expert)

1 2 3 4 5

Overall, how comfortable are you performing experiments in a lab? (1 = not comfortable at all, 5 = very comfortable)

1 2 3 4 5

How would you rate your ability to use a micropipettor? (1 = none, 5 = expert)

1 2 3 4 5

How would you rate your ability, and comfort level, with following a protocol you have never seen before? (1 = low, 5 = high)

1 2 3 4 5

How would you rate your report writing ability? (1 = none, 5= expert)

1 2 3 4 5

Overall, how would you rate your comfort level with science courses? (1 = not comfortable at all, 5 = very comfortable)

1 2 3 4 5

Appendix 3. Table 1. Student Self-Assessment Questionnaire Data.

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Student 1	beginning	3	1	3	3	4	3	1	2	1	5	3	4	4	4
	end	3	2	3	3	4	4	4	4	4	4	4	3	3	4
	Δ	0	1	0	0	0	1	3	2	3	-1	1	-1	-1	0
Student 2	beginning	4	2	3	4	3	3	2	2	3	5	5	4	3	4
	end	4	3	3	4	4	4	4	4	4	5	5	5	4	4
	Δ	0	1	0	0	1	1	2	2	1	0	0	1	1	0
Student 3	beginning	4	4	3	4	3	3	2	2	2	5	5	3	4	4
	end	3	3	3	4	3	3	4	4	3	4	5	4	5	5
	Δ	-1	-1	0	0	0	0	2	2	1	-1	0	1	1	1
Student 4	beginning	2	4	4	3	1	3	1	3	1	5	5	3	3	5
	end	2	4	4	4	4	4	4	4	3	4	5	3	4	5
	Δ	0	0	0	1	3	1	3	1	2	-1	0	0	1	0
Student 5	beginning	4	3	4	4	3	3	2	2	1	4	5	2	4	4
	end	4	4	4	5	5	4	5	5	4	5	5	3	5	5
	Δ	0	1	0	1	2	1	3	3	3	1	0	1	1	1
Student 6	beginning	4	4	4	5	4	3	2	2	4	4	4	2.5	4	5
	end	4	4	5	5	4	4	4	3	4	3	3	3	5	5
	Δ	0	0	1	0	0	1	2	1	0	-1	-1	0.5	1	0
Student 7	beginning	3	3	4	3	4	3	2	2	3	4	2	3	3	4
	end	3	1	4	2	3	3	5	4	3	5	4	4	2	3
	Δ	0	-2	0	-1	-1	0	3	2	0	1	2	1	-1	-1
	AVG Δ	-0.14	0.00	0.14	0.14	0.71	0.71	2.57	1.86	1.43	-0.29	0.29	0.50	0.43	0.14
Query		basic science background			scientific reasoning ability	basic vs applied science	understanding of forensic science				lab skills			report writing	overall science ability
2013 Data	AVG Δ	-0.1	0.7	0.3	0.8	0.7	0.3	1.7	1.7	1.2	0.9	0.9	1	0.6	0.4
Change: 2013 to 2015	2015 gain from 2013	-0.04	-0.70	-0.16	-0.66	0.01	0.41	0.87	0.16	0.23	-1.19	-0.61	-0.50	-0.17	-0.26