
“Worst Thief Ever”- The Use of a Storyline to Engage Students in a Traditional Hands-on Lab Experience

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Abstract

A traditional anatomy lab using microscope slides to examine the structures of the integumentary system was enhanced to increase connections to the real world, student engagement, and interest in the topic by adding a forensic storyline where students examined structures of the integument in order to “solve the crime”. Student perceptions regarding the addition of the storyline to the lab found that 88% of students reported that the storyline increased the connections they made between the lab and the real world. Eighty-six percent of students stated that the storyline increased their interest in the lab and 83% said that it made them more engaged in the lab. Sixty-three percent of students felt that the storyline helped them to learn the material better. A five-step strategy guided the conversion of a typical hands-on anatomy lab exercise into an engaging experience based on a storyline using materials commonly found in the lab. This strategy serves as a template to transform lab exercises into experiences that use both a storyline and a hands-on activity as drivers of student learning.

<https://doi.org/10.21692/haps.2023.007>

Key words: storyline, hands-on learning, integumentary system, anatomy laboratory

Introduction

The laboratory is an important part of a Human Anatomy and Physiology course. The lab offers opportunities to manipulate materials and observe real life examples of anatomy (Dennis and Creamer 2022; Steger et al. 2020). Labs are usually divided by topic, such as the muscular system or cardiac physiology. Background information is often provided at the beginning of a session or as a pre-lab assignment while the in-lab activity focuses on materials such as microscope slides or dissections that students work with and observe. An example of a topic commonly taught in the anatomy lab is the integumentary system. Typical learning objectives for this lab may include: 1) label the layers of skin, 2) explain the function and importance of the skin layers (dermis and epidermis), 3) label and discuss the anatomy of hair and nails, as well as understanding skin pathologies or injuries such as burns, etc. A characteristic way to meet these objectives is microscopic examination of slides of skin, hair and nails. However, often students use the microscope activity as a list of requirements that must be “checked-off” before they can leave, rather than an exercise in critical thinking and understanding of a topic. Simply doing a lab exercise does not necessarily translate into learning from it (Hodges 2020).

Student activity does not always equate to student learning. Creating classroom environments that motivate students to learn about a topic and to think critically is a goal of most anatomy educators (Freeman et al. 2014; National Research Council 2012). Examples from the literature of

strategies designed to meet this goal include using real-world situations and problems to promote motivation to learn and interest in a topic; these are major tenants of both context-based learning and project-based learning where information is presented within a knowledge framework rather than as detached facts (Condliffe 2017; Sevia et al. 2018). Setting the stage for learning with basic background information is crucial to learning anatomy as there are some concepts that students must know before they move to higher order thinking skills. Using appropriate disciplinary tasks to help students build knowledge is an important part of solving problems and applying anatomy to real-world situations (Dunbar 1995; Furtuck and Penuel 2019). However, producing experiences that build basic content knowledge, engage and motivate students and allow students to work together to solve problems can be daunting.

Project-based learning (PBL) strategies help students meet their learning goals. One factor common to good PBL lessons is the presence of a cohesive storyline that helps students make sense of the phenomenon (Nordine et al. 2019; Penuel et al. 2022; Reiser et al. 2021). The storyline drives the context of the content and supports social interactions among students as well as making anatomy content meaningful (Miller and Krajcik 2019). The storyline also provides motivation to learn (Reisener et al. 2021). While the literature reports several variations of using a storyline to promote engagement (Isabelle 2007; Penuel et al, 2022; Roth et al.

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2011), most reports focus on the storyline as the sole driver of student engagement.

Hands-on learning is another pedagogy associated with active learning that drives student engagement and can produce gains in comprehension. Hands-on activities, or "practice-base" exercises can increase knowledge retention and problem-solving skills (Ford 2015; Oseuntuyi 2021). Students prefer hands-on learning in the anatomy lab over exercises that do not involve the manipulation of materials (McDaniel and Daday 2017). The benefits of active learning, such as hands-on labs, are well established but it is common for college anatomy students to work through hands-on labs without thinking about what they are doing (Freeman et al. 2014).

A different approach to the construction of lab exercises is to use multiple drivers of student engagement instead of relying solely on hands-on activities or problem-based learning. This paper describes a simple way to add a storyline to a traditional hands-on anatomy lab to provide interest and context while maintaining the learning objectives and activities of the lab. The combination of a storyline with a hands-on lab peaks student interest, fosters collaboration and garners the benefits of hands-on learning. The hands-on storyline example lab presented in this paper is an approach to teaching concepts of the integumentary system (Appendix 1).

The storyline focuses on the theft of a painting from a local art gallery where the "worst thief ever" left all kinds of evidence from his/her integumentary system. Students must study the parts of the integumentary system to "solve the case"! They learn basic anatomy while working with reference slides and then compare slides containing evidence from the crime scene to make deductions about the identity of the thief. Students make connections between microscopic anatomy and human phenotypes such as melanin production in skin pigmentation, tattoo ink in the dermis, epidermal ridges on fingerprints, and the structure of hair as it relates to texture and color. While this lab emphasizes the integumentary system, the basic premise of this approach is not limited to this concept and could be used to teach other topics in anatomy and physiology. The development of a lab within this framework does not reinvent the wheel but enriches lab experiences that have been used successfully in the past by adding context through a storyline.

Methods

Design of the hands-on storyline Integumentary Lab

Modifying a traditional lab to include an engaging storyline involves five steps (Figure 1 and Appendix 2). The first steps are to identify the goals of the lab, determine how these goals are usually met in the traditional lab, and to procure the materials that are commonly used for the lab. The fourth

step is to analyze how the materials used to meet the lab goals can be worked into the storyline as pieces of evidence and the final step is to modify the storyline provided in this paper to fit the evidence and make the storyline interesting for your students.

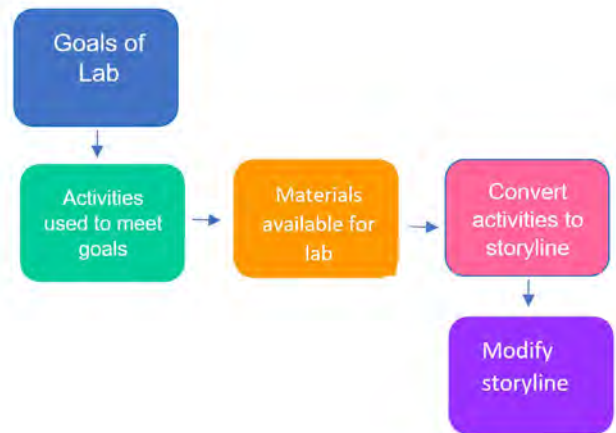


Figure 1. Steps for adapting a hands-on lab to a storyline format.

The example hands-on storyline lab for the integumentary system presented in this paper (Appendix 1) was built using materials commonly present in the lab, produced by the instructor, or purchased from a vendor. The template in Appendix 2 outlines the method to develop a hands-on storyline lab using common items in the lab. Effective active learning strategies start with a set of well-defined learning objectives (Barkley et al. 2014). These goals should guide instruction and serve as the basis for assessment. What follows is the list of learning goals set for this activity by the author.

By the end of this laboratory exercise students will be able to:

- Identify and label the layers of the epidermis.
- Discuss the types of cells found in each epidermal layer.
- Differentiate between the structures and functions of the epidermis, dermis, and hypodermis.
- Explain the roles of melanocytes in skin pigmentation.
- Construct a theory of why tattoos are not placed in the epidermis.
- Appraise fingerprints and point out the layers of the skin creating the ridges.
- Label the parts of a human hair.
- Contrast human hair with hair from other animals.
- Evaluate different types of rashes and burns.
- Hypothesize who you believe the thief to be and deduce which suspect best fits the criteria based on the evidence gathered at the crime scene.

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After constructing the learning goals for the lab, a lab activity task was assigned to each objective. For example, looking at microscope slides of both pigmented and non-pigmented skin as well as skin that is tattooed would meet the goals regarding skin layers. Table 1 exemplifies how commonly used materials from the lab can be matched with pieces of evidence that could be used in a crime scene. In this way, past successful lab activities and their accompanying materials could be inserted into an engaging storyline that meets the specific goals of the lab. Note that the materials listed in Table 1 are not an exhaustive list of the possibilities of resources that could be used but offers ideas and a framework to guide unique lab experiences.

Teacher Preparation-Hands-on Component

Preparation for the lab used both purchased supplies and materials produced by the instructor. The items listed "to

purchase" in Table 1 are commonly present in many anatomy labs but may need to be relabeled to fit with the story. For example, the slide labeled "Stratified Squamous Epithelium" or "Skin" from the manufacturer should be relabeled "Sample Skin" to indicate that this is skin from the crime scene. Slides labeled "Pigmented or Nonpigmented Skin" from the manufacturer should be relabeled as "Reference Skin" so that students know to use these as a comparison for the crime scene evidence. Table 1 summarizes the materials used in the example integumentary system lab that are assembled into an "Evidence Box" and a "Reference Box" for students. Students compared the samples in the "Evidence Box" with the materials in the "Reference Box" and made decisions about the identity of the thief. For online sections, this "Evidence Box" can be turned into a digital format, such as a Power Point presentation, but this format loses the advantages of hands-on learning.

Material	Purchase	Produce	Produce Instructions	Label or Relabel
Slide: Stratified Squamous Epithelium or Skin	Yes			Sample #1: Skin from Crime Scene
Slide: Non-pigmented Skin	Yes			Reference #2: Skin-Non-pigmented
Slide: Pigmented Skin	Yes			Reference #3: Skin-Pigmented
Slide: Tattooed Skin	Yes			Reference #4: Tattooed Skin
Pictures of Rashes: <ul style="list-style-type: none"> ➤ blister ➤ vesicular ➤ bullae ➤ pustule ➤ papule ➤ fissure 	No	Yes	Print pictures of each "rash" and glue them to individual notecards.	Rash References: #1-6
Picture of Degrees of Burns	No	Yes	Print pictures of first, second, and third-degree burns	Burn References: #1-3
Picture of a forearm with poison ivy (vesicular rash)	No	Yes	Print a picture of an arm with poison ivy	Evidence #2: Rash described from crime scene
Picture of Fingerprint	No	Yes	Create a card with a fingerprint - You will need two of these; one from the crime scene and one as a reference	Evidence #3: Fingerprint from crime scene
Reference Fingerprints	No	Yes	Produce from different people or print three different fingerprints and glue to a notecard	Reference Fingerprints: #1-Carl Circle #2-Sally Square #3-Tony Triangle
Fingerprint Ink Pad and Magnifier	Yes			
Slide-Evidence Hair	Maybe	Maybe	You can purchase this slide or produce it by gluing human hair with clear glue to a microscope slide.	Evidence #4: Hair from crime scene
Slide(s)-Reference Hair Slides-Hair Comparison Microscope Slides <ul style="list-style-type: none"> ➤ cat hair ➤ sheep hair (wool) ➤ human hair 	Yes			Reference Hair Slides- #1- Cat Hair #2-Sheep Wool #3- Human Hair

Table 1. Materials Needed for Hands-on Storyline Integumentary System Lab

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Classroom Management

All materials, except for the hands-on manipulatives, were available to the students electronically through the university's Learning Management System (LMS). Pre-Lab background information for this lab was delivered to students through an online presentation that introduced students to the basics of the integumentary system. In addition, students were assigned online, pre-lab homework to be completed prior to coming to the lab (Table 2). The physiology of the integumentary system was more deeply explored in lecture, so students came to lab prepared to learn and to work. The lab session started with a short (5-10 question) quiz to hold students accountable for the pre-lab material. Once the quiz was complete students were prompted to begin the hands-on case study lab activity.

Students worked in groups to perform the hands-on case study lab activity and were encouraged to use their electronic devices, lab materials and e-textbooks to solicit information. Each section of the lab began with a series of discussion questions that students discussed and answered before progressing to the hands-on part of the crime scene analysis. The instructor circulated through the lab interacting with the lab groups, making sure that students were discussing lab questions before beginning the lab, asking probing questions, and guiding instruction.

Student Perception of the Hands-on Case Study

After completing the "Worst Thief Ever" lab, students were assigned a voluntary, short Qualtrics (<https://www.qualtrics.com/>) survey about their perceptions of how the storyline of the crime scene affected their engagement, interest, and ability to make connections or their learning of the material.

The survey was composed of 5 multiple choice questions and open-ended question about what students liked about including the storyline in the lab and was made available through the course LMS. The project was approved by the Internal Review Board (IRB) of Western Kentucky University (#1951249-1), and informed consent was obtained from all participants.

Results

Students (n=132) were surveyed on how using a storyline as a pedagogical tool in the lab affected their 1) interest in the topic, 2) connections between anatomy and the real world, 3) perceived learning of the material and 4) engagement with the content. Eighty-six percent of students surveyed reported that the storyline of "catching the thief" increased their interest in learning about the integumentary system compared to looking at the slides without context. Eighty-eight percent of students replied that the storyline helped them make connections about the integumentary system and the real world. Sixty-three percent of students thought that the storyline helped them learn the material better while 29% were neutral on this point. Only 8% disagreed that the storyline helped them master the material about the integumentary system. When students were probed about how the storyline affected their engagement in the lab, 83% stated that they had higher levels of engagement with the material because of the storyline.

Timeframe	Roles of Instructor	Student Involvement
Pre-Lab	Post online pre-lab presentation Post online homework	Watch and learn pre-lab material Complete pre-lab homework
During Lab	Administer short quiz Interact with student groups	Take content quiz Engage with groups to use the materials in lab to complete the lab exercise

Table 2. Overview of the Structure of the Example Lab

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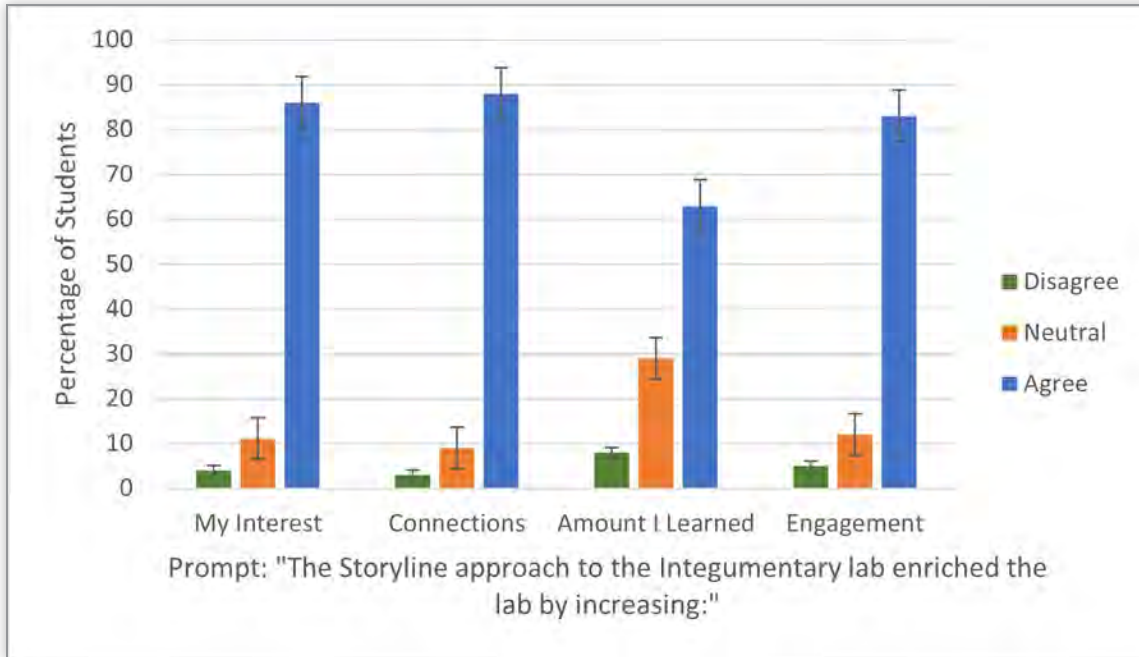


Figure 2. Student responses to survey about how storyline impacted the integumentary system lab. This figure shows student responses to survey items regarding 1) interest in the topic, 2) connections between anatomy and the real world, 3) perceived learning of the material and 4) engagement with the content.

When asked to choose how the storyline impacted the integumentary system lab session, 61% of students said that the storyline helped them make connections to the real world, 28% of students reported that the storyline made the topic more interesting/engaging, while only 2% did not like the storyline aspect of the lab.

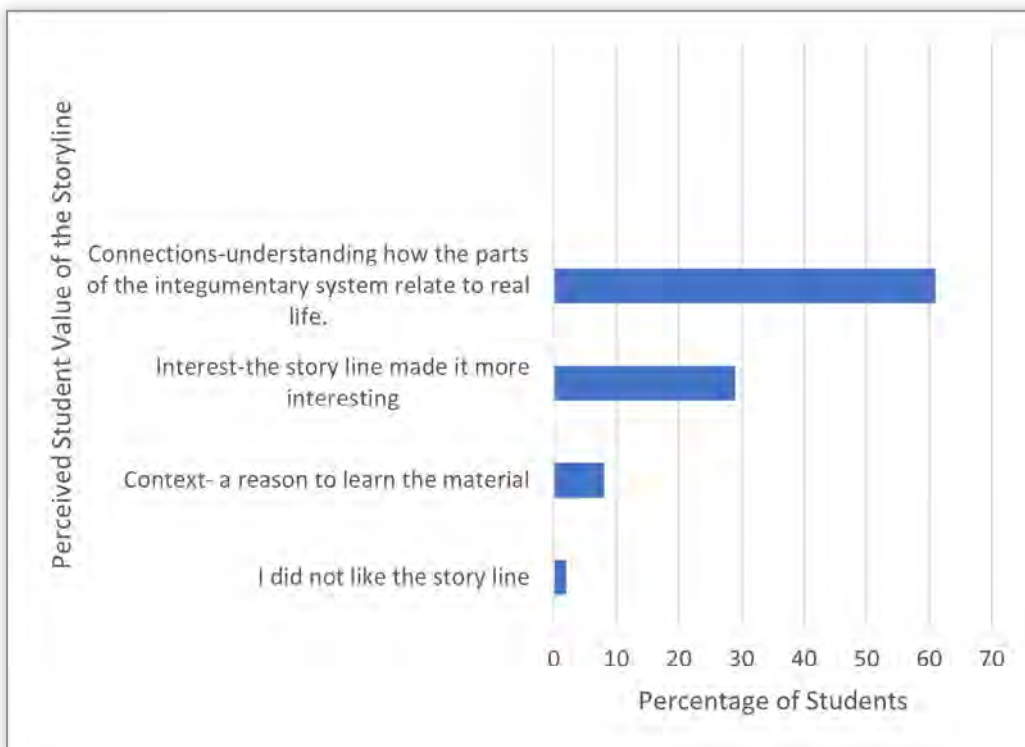


Figure 3. Student perception of the main value the storyline added to the integumentary system lab. This figure reports student perceptions of the value that the storyline added to the integumentary system lab. 1) Connections between anatomy and the real world, 2) storyline made the content more interesting, 3) storyline provided context, a reason to learn the material, 4) students didn't like the storyline.

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The responses to an open-ended prompt exploring how the storyline impacted their perception of the integumentary system lab were positive. One student wrote *"I love true crime already, so I really enjoyed doing this activity. It was beneficial because you look for smaller differences and have to know what the differences mean in order to solve the case; therefore, it requires more thinking and engages the students more. For example, the skin sample from the crime scene had more melanin being carried by the keratinocytes than someone who is lighter in complexion. The storyline idea engages students more and encourages them to learn. For me, it's hard not to fall asleep and often catch myself wondering because it's kind of boring-the material is interesting, it's just difficult to force myself to pay attention. With this, I was doing something, so it encouraged me to think and made me super excited to learn."* Another student reported, *"It gave me an incentive to complete and fully participate in the lab rather than just learning. I thought it was interesting when we looked at slides from the crime scene under the microscope and compared them to sample/control slides"*. Another student suggested that the storyline improved collaboration between group members when he/she said, *"It helped me make connections with the material to make how and why connections. Secondly, I feel it made my lab group help work and communicate better all at once because of the interesting teamwork establish to learn and "find the culprit!"*" While these are just a few of the comments written about the storyline aspect of the lab, most of the open-ended comments were positive. During the lab, the room was bustling with discussion, participation, and energy as students engaged with the materials.

Discussion

Selecting and implementing the best pedagogical approach for teaching anatomical concepts can be challenging. Studies suggest that active learning strategies support student achievement by engaging students in learning (Cavanagh et al. 2018; Freeman et al. 2014; Hodges 2020; Wieman 2014). However, simply doing tasks does not ensure that learning takes place (Andrews et al. 2011). There is a need for students to invest in the activity, meaning that it must connect to the student on an emotional level (be interesting) and a behavioral level (must be fun), and the time invested in the activity needs to payoff (Cavanagh, et al. 2016; Hodges 2020). From a learning perspective, students need to make connections to the real world and be able to apply their knowledge to novel situations (Sevian et al. 2018). Adding a collaborative layer to an activity, by having students to work in groups, increases student success by prompting deeper discussions and the ability to rely on others to help answer hard questions (Bitskinashvili 2018; Nokes-Malach et al. 2015).

The storyline approach to hands-on learning presented in this paper contains the components of effective active learning. Most students reported that the storyline approach increased both their interest and engagement in the topic

compared to if they had just looked at the slides (done an activity) alone (Figures 1 and 2). It is not surprising that the greatest reported effect of using a storyline was on students making connections to the real world. Instead of looking at and memorizing layers of skin, students were challenged to learn the anatomy of the skin with the goal of recognizing identifiers of the thief.

Students were intrigued to find tattoo ink in the dermis and quickly drew the conclusion that tattoos placed in the epidermis would not last. Many students shared their own tattoo experience with their groups. The same was true of the fingerprint analysis. While understanding the dermal papillae and epidermal ridges, they had to intently study these to determine the fingerprint pattern. They were eager to make their own fingerprints and compare them with the "reference samples". Several students plucked out one of their own hairs and examined it under the microscope, comparing it to the reference slides as well. Students were interested and engaged and made connections to the real world. What could have been a stale, boring lab became entertaining and educational by the addition of the storyline.

Conversely, adding a hands-on component to a simple case study or to a storyline can increase student involvement and achievement (Bretz 2019; Hofstein and Mamlok-Naaman 2007; McDaniel and Daday 2017; Steger et al. 2020; Wang and Tseng 2018). Case studies are very much like storylines. They offer real-world examples of clinically based scenarios that lead to deep discussions and critical thinking (Gade and Chari 2013; Latif 2014; McFee et al. 2018). Comparing the hands-on storyline approach to the facets of the interactive, constructive, active passive (ICAP) framework for student engagement, the addition of a rich storyline moves students from a "passive" level of engagement, where students receive and recall information, through the "active level" where they manipulate and integrate information, to the "constructive" level where information is generated and transferred and, finally, to the "interactive" level where students discuss and co-create thoughts and information (Chi and Wylie 2014). Moving students to the "interactive" level of engagement on the ICAP framework helps students construct knowledge and work with others to process information at a higher cognitive level (Hodges 2020). It is the merger of the case study/storyline approach with the hands-on lab that makes this method unique and a valuable pedagogical strategy to engage students in minds-on, active learning.

While commercial forensic labs are available for purchase by scientific supply companies, these kits often focus on basic scientific inquiry, observation, and data collection rather than specific topics covered in the anatomy lab, such as the integumentary system. Using simple materials present in most anatomy labs, a storyline can be added to existing labs that increase interest but still meet the specific learning objectives of a course. For example, adding a vial of simulated blood to the storyline highlighted in this

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paper would allow the instructor to focus on characteristics of blood such as blood typing or blood disorders such as sickle cell anemia if these were goals of the course. Since the objectives for this case study focused on the integumentary system, this author did not include blood evidence in the "Evidence Kit". Using this as a storyline framework allows anatomy instructors the flexibility to produce engaging, hands-on labs using materials they already possess to meet learning objects of the course.

This methodology is not limited to a forensic storyline or the integumentary system. A basic histology lab where students look at microscope slides of tissues and learn their characteristics could be modified to become a hospital pathology laboratory where students need to understand the reference slides to diagnose patient diseases and make recommendations for treatment. A bone lab could be converted to an archaeology dig where information about the people who lived in a region could be deduced based on the bone size and structure. Learning bone markings could help students reconstruct the bones to explain how the people lived and died. Adding a storyline to a hands-on standard lab should help to engage students, initiate conversations and stimulate higher order thinking. While the addition of storylines to hands-on labs has many benefits, these advantages could be extended to the digital world. This author challenges commercial e-text and e-materials publishers to incorporate storylines into virtual lab experiences to provide context and engage students during digital simulations and lab activities.

Conclusions

Using a storyline created specifically to cover lab objectives is an effective way to increase student interest in the content and engagement in a hands-on lab. Adding context and intrigue to lab exercises in which students regularly participate, makes students more willing to invest effort in learning the material and ultimately could improve student success. Storylines can be easily added to traditional anatomy lab experiences to meet the goals of the course.

About the Author

Dr. Kerrie McDaniel is an associate professor in the Department of Biology at Western Kentucky University. She is responsible for the Human Anatomy and Physiology program at the university which involves writing curriculum, teaching, managing teaching assistants (TAs), and organizing materials. Her research interests include student learning and engagement, the use of e-texts and e-learning materials, and bolstering the STEM pipeline by inspiring middle school science teachers through the National STEM Scholar Program.

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Appendix 1: An Example Hands-On Storyline Integumentary System Lab

The Case:

As a member of the *(insert the name of your city or college here)* Task Force on crime, it is your job to help keep the city safe. You have been especially busy lately because of a criminal dubbed the Bonehead Bandit. This crook is responsible for a series of robberies of local business and well-known residences in the area. He/she is most noted for stealing rare pieces of art. Until recently he/she has remained undetected leaving very little evidence for your task force to work with. Last night, however, an eyewitness got a brief glimpse of the thief as he/she slipped out the back door of the First National Federal City Bank downtown. While the thief escaped with a lesser-known painting by Grant Wood entitled "Southern Gothic", he/she left a few clues.

The Suspects:

- **Carl Circle:** Carl is a gardener who landscapes for many of the businesses and residences in the area. He lives in a very nice condominium and drives a new corvette. His brother works for the Metropolitan Gallery of Art in New York City. Carl is Caucasian with curly brown hair, gray eyes and a lizard tattoo on his forearm. He has two indoor calico cats and a goldfish.
- **Sally Square:** Sally is a teller at the Third National People's Bank. She was recently passed over for a promotion for manager. She lives in a nice subdivision in a single dwelling home with her sister, Susan. Sally studied art in college and participates in local art shows at the Capital Arts Theatre. In addition to painting, Sally knits sweaters out of sheep's wool that she spins into yarn. Sally has recently purchased tickets for a European cruise to visit her cousin in Poland, where many of her family is from. Sally is Caucasian and has curly blonde hair and green eyes. She has eczema but no pets.
- **Tony Triangle:** Tony is a local real estate developer. He specializes in strip malls. Recently his three largest tenants have pulled out of their lease leaving Tony low on funds. He has a grudge against three of the banks in town because they are putting pressure on him to pay his loans. Tony lives in a penthouse apartment in one of his properties with his girlfriend, Fritzy. Tony is Caucasian and has straight black hair, and brown eyes. He has a tattoo of a clipper ship on his arm. He recently returned from a "camping trip" deep in the woods where he was checking on his "crop". He slept in a tent with his associates in an area populated by poison ivy. Tony does not have any pets.

Evidence:

Witness Statement: Rubeus Red	Report By: Officer Vesalius
Mr. Red stated that he was taking out the garbage at the First National Federal City Bank when he noticed that that "Southern Gothic" painting was missing from the wall. He quickly glanced and saw a dark figure scurry out the door. He particularly noticed that the culprit was not wearing a glove on his/her left hand and that the hand was covered in some sort of rash. He also noticed that the crook was Caucasian, and that his/her arm was bleeding. The officer examined the doorframe and found a small piece of tissue, presumably from the forearm of the criminal and a clump of hair, both of which were entered into evidence. Mr. Red also noted a dark mole on the back of the culprit's hand.	

Forensic Evidence Collected-Sample from Crime Scene:

Sample	Description	Collected From
1	Skin tissue	Doorframe of bank
2	Description of lesions on hand of culprit	Eyewitness account
3	Fingerprint	From wall near missing painting
4	Oil from fingerprint	Wall near missing painting
4	Hair	Stuck in blood on doorframe
5	DNA <ul style="list-style-type: none"> • DNA fingerprinting • Ancestry analysis 	From skin tissue

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Reference Materials

Reference	Description	Use
1	Skin Slides <ul style="list-style-type: none"> • Nonpigmented Skin • Pigmented Skin • Tattooed Skin 	To identify the layers and structures in each layer of the skin to compare to the sample from the crime scene.
2	Reference Rash Cards <ul style="list-style-type: none"> • Blister • Vesicular • Bullae • Pustule • Papule • Fissure 	To identify the types of skin lesions and their possible sources
3	Reference Fingerprints <ul style="list-style-type: none"> • Suspect 1 • Suspect 2 • Suspect 3 	Compare the fingerprints from the crime scene to the reference prints.
4	Reference Hair Slides <ul style="list-style-type: none"> • Human Hair Slide • Cat Hair Slide • Sheep Hair Slide (Wool) • Curly Hair Slide • Straight Hair Slide 	Compare with the hair from the crime scene to determine if the hair is human and if so, if it is straight or curly.

Your Task:

Help the Task Force on Crime solve this mystery by examining the evidence, answering the questions about the evidence as you examine it, and deduce who you believe the thief to be. Complete the evidence analysis form as you carry out your investigation.

1. Skin Tissue Analysis: Skin Layers, Skin Color and Tattoos

A. Analysis Questions. These are questions that you need to be able to answer to analyze the skin taken from the crime scene. Work in your groups and discuss these questions before you start looking at the slides.

- What are the layers of the skin?
- What specific types of cells do you find in each layer?
- What information about the thief do you gain from the microscopic examination of skin from the crime scene?
- What causes skin color?
- Which cells are involved in skin color?
- Where would you find the difference in skin color in the layers of the skin?
- Can a person's skin color change? How?
- What is a tattoo?
- How are tattoos produced?
- Into which skin layer is the ink of a tattoo placed?
- Does it matter which layer of the skin the ink of a tattoo is placed? Why?
- Which cells of the skin would be involved in the immune system of the skin?

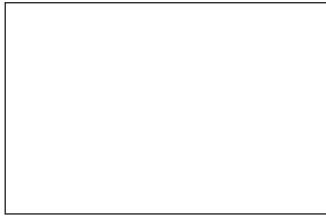
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B. Task Instructions

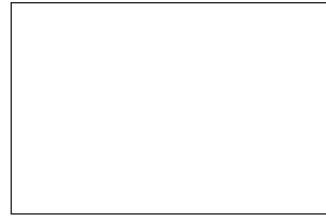
a. Examine the reference slides of skin. Make sure that you can label all the layers.

Draw what you see and label the layers.

- What is the difference in the pigmented and nonpigmented skin reference slide?
- In which layers of the skin do you see these differences?



Draw pigmented skin



Draw nonpigmented skin

b. Examine the Reference slide of tattooed skin. How does this slide differ from the first two reference slides you have observed?



Draw what you see from the tattooed skin reference slide

c. Examine the slide of the skin taken from the crime scene (doorframe). Do you see the same layers in the slide from the crime scene as the reference slides?



Draw the skin from the Crime Scene

d. How is the skin from the crime scene the same and different from the reference slides?

What information do you gain from examining the crime scene skin slide and comparing it with the reference?

C. Does the culprit have a tattoo? How can you tell?

2. Record your results in the Evidence Analysis Form at the end of the lab.

3. Hand Lesion Analysis

A. Analysis Questions. You need to understand the following in order to analyze the lesions observed at the crime scene.

Work in your groups to discuss and answer the following questions before you perform your analysis.

- What is the difference between the following?
 - burn
 - blister
 - vesicle
 - bullae
 - pustule
 - papule
 - fissure
- When a blister forms, which two layers separate?
- What are some causes of dermatosis and dermatitis?
- Are all burns caused by heat? What are some other causes?
- Which cells in the skin are responsible for producing moles?
- What is the difference between a mole and a freckle?

B. Task Instructions

- a. In your groups look at the reference pictures of the rashes. Discuss what circumstances might lead to those rashes.
- b. Examine the picture of the rash derived from the eyewitness account of the crime scene. Compare it with other types of rashes. What type of rash is found on the thief?
- c. Hypothesize how the thief might have obtained his/her rash.

C. Results Analysis-Record your results in the Evidence Analysis Form at the end of the lab.

4. Fingerprint Analysis

A. Analysis Questions/Background about fingerprints. Work in your group to discuss and answer these questions before you examine the fingerprints.

- What produces a fingerprint?
- Which skin layers are involved in producing a fingerprint?
- How do fingerprints differ from each other?
- Diagram the layers of the skin involved in producing a fingerprint.
- What do the following terms mean with regard to fingerprint analysis? What forms these shapes on a fingerprint?
 - Arch
 - Whorl
 - Loop
 - Tent Arch
 - Pocket Loop
 - Double Loop

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B. Task Instructions

- a. Use the jeweler's loupe (magnifying glass) to examine the fingerprints of the three suspects in the reference slide box.
- b. Examine the fingerprint from the crime scene and compare it to the reference slides?
Do any of the fingerprints match? What does this mean? Does the evidence point to a specific suspect?
- c. Use the ink pad to produce your own fingerprints and examine them for shape. Describe your fingerprints.



Use the ink pad to produce your own fingerprint. What shapes do you see?

C. Results Analysis-Record your data in the Evidence Analysis Form at the end of the lab.

5. Hair Examination

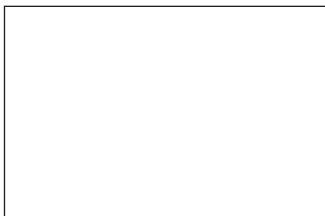
A. Analysis Questions and Background about hair.

In your groups discuss and answer the following questions before you start looking at the slides.

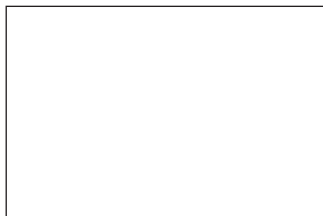
- What are the layers of human hair?
- What are the structures of the human hair?
- Why does it not hurt when you get your hair cut but it does hurt when it is pulled?
- Could we get DNA evidence from a hair?
- How does human hair differ from animal hair?
- What produces hair color? Can you see this under a microscope?
- How does straight hair differ from curly hair under the microscope?
- Does the hair look different under the microscope than you expected? In what way?

B. Task Instructions

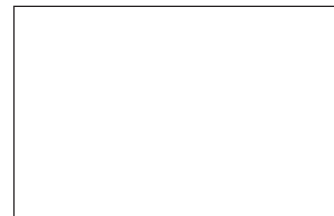
- a. In your groups, examine the hair samples provided in the Reference slide kit. Identify the parts of the hair. Draw and label what you see.



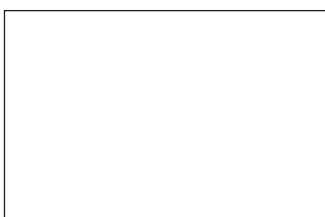
Human Hair



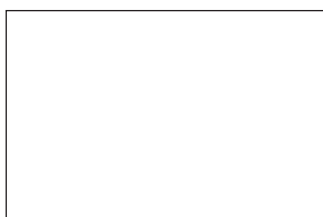
Cat Hair



Sheep Hair (Wool)



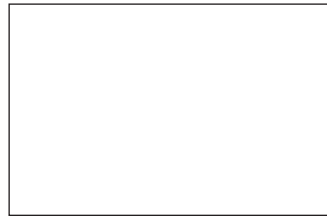
Straight Hair



Curly Hair

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b. Examine the hair from the crime scene. Draw and label what you see below.



Hair from Crime Scene

- c. Is the hair found at the crime scene human hair? If not, what type is it?
- d. Can you tell if the hair is straight or curly or what color it is?
- e. What information does the hair from the crime scene provide you to help you solve the crime?
- f. Pull out a strand and look at your own hair under the microscope. How does this differ from the slide?

Evidence Analysis Form

Task Force on Crime Members: _____

Section Number: _____

Results

		Description of Results from Crime Scene	Results/Observations
1	Skin	Layers (What skin layers did you observe): Pigmentation: Was the skin pigmented? Tattoo (Present/Absent):	
2	Lesion	Type of Lesions: What types of skin lesions were observed from crime scene? Probable cause of lesions?	
3	Fingerprint	What shapes were observed from the friction ridges from the crime scene fingerprint? Arch Tent Arch Whorl Left Pocket Loop Left Loop Double Loop Right Loop Right Pocket Loop	
5	Hair	Was the hair from the crime scene human? Cat? Sheep? Other? Could you tell the color of the hair? Was the hair straight or curly?	

Based on the evidence that you analyzed, who do you think the thief is?

Appendix 2: Hands-on Storyline Scenario Template

This template outlines steps towards turning a basic anatomy lab into an engaging experience based on a crime scene storyline. The example used in this paper is a lab for the integumentary system. Many different anatomy labs could be modified to fit this format.

Step 1: What are the goals for this lab?

Step 2: What lab do you usually conduct to meet these goals?

Step 3: What materials do you have available or can you purchase/procure to conduct this lab.

Step 4: How can these activities/materials be used in a crime scene? Turn the materials into crime scene evidence.

Step 5: Modify crime scene storyline to fit your needs.

EXAMPLE. From typical integumentary system lab

Step 1: What are the goals for this lab (these may include HAPS learning or process outcomes)?

Examples: Goals for the integumentary system lab may include (others listed in body of paper):

- Identify and label the layers of the epidermis.
- Differentiate between the structures and functions of the epidermis, dermis, and hypodermis.
- Explain the roles of melanocytes in skin pigmentation.
- Construct a theory of why tattoos are not placed in the epidermis.
- Appraise fingerprints and point out the layers of the skin creating the ridges (dermal papillae and epidermal pegs).
- Label the parts of a human hair.

Step 2: What lab do you usually conduct to meet these goals?

Examples: Typical activities for the integumentary system lab may include:

- Use microscopes to examine prepared slides of skin.
- Look at different fingerprints and compare and contrast them.
- Use microscopes to observe prepared slides of hair from humans

Step 3: What materials do you have available or can purchase/procure to conduct this lab.

Examples: Typical materials for the integumentary system lab may include:

- Prepared microscope slides of skin and hair
- Images of different fingerprints

Step 4: How can these activities/materials be used in a crime scene? Turn the materials into crime scene evidence.

Example: How the goals and materials from a typical integumentary system lab can be turned into a lab with a crime scene storyline.

Goal	Material	Evidence
Example		
-Identify layers of epidermis -Rolls of melanocytes -Location of tattoo -Dermal Papillae/epidermal pegs identification	Prepared Microscope slides: a. Pigmented skin b. Non-pigmented skin c. Tattooed skin d. A second copy of one of the slides above	These will serve as reference slides. I will add a fourth slide where I cover up the label as the crime scene skin. Students will compare crime scene to references.
-Fingerprints-analysis and identification of dermal papillae and epidermal ridges	Fingerprint Cards a. Laminated cards with various fingerprints (from suspects) b. Laminated card from crime scene Ink to produce own fingerprints a. Compare own fingerprint with cards	The laminated cards from the suspects will serves as references to compare crime scene fingerprints.
-Label the parts of a human hair	Prepared Microscope slides: a. Human hair b. Hair from sheep and cat	In the storyline, one of the suspects knits with wool yarn and the other has a cat. Students will compare crime scene hair with references.

Step 5: Modify Crime Scene storyline to fit your needs.

Example: Change the names of the suspects so that they are interesting for your students, such as the names of other faculty members in the department. Provide only the evidence that will help the students meet the goals of the lab.

