

Kinundrum

A problem-based multimedia learning application for kinesiology and anatomy

SCOPE DOCUMENT

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A. Design Requirements (in detail)

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Project Title

Kinundrum: a problem-based multimedia learning application for first-year kinesiology students

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Introduction

Although anatomy is the foundation of all health and medical fields, there has been widespread decline in resources and time allocated to anatomy education. In response, instructors are increasingly incorporating e-learning resources to supplement lectures and dissection labs. E-learning is advantageous due to its flexibility, accessibility and low re-use costs. However, most current e-learning resources are not designed based on research in education, psychology or neurobiology. Research in anatomy education demonstrates that anatomy should be presented as basis of spatial reasoning and problem solving. Additionally, psychological and neurobiological research has produced empirically-derived criteria for effective instructional multimedia design. Given significant advancements our understanding of learning and in multimedia technology, there is untapped potential for creating an e-learning resource that incorporates both to facilitate learning in anatomy students.

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Goals and Objectives

Kinundrum is a problem-based multimedia e-learning application that guides students through case studies on lower limb anatomy at increasing levels of difficulty. As a self-directed adaptive application, each case study incorporates feedback and remedial exercises that address the needs of individual students. The primary goal of this learning resource is to engage undergraduate anatomy students in deep and active learning of lower limb anatomy.

To order to reach this goal, the following objectives must be realized:

- 1 Compose case study modules and questions that
 - allow students to review, apply and contextualize their lower limb anatomy knowledge
 - develop critical thinking, reasoning and problem-solving skills
 - teach students how to effectively learn and study anatomy
- 2 Design and create instructional multimedia assets adhering to principles derived from educational psychology and neurobiology that
 - reduce cognitive load and avoid elements that don't contribute to learning
 - direct attention to relevant information
 - facilitate the formation of coherent mental models
- 3 Incorporate features that allow the application to address and adapt to individual user needs. (feedback for correct/incorrect answers, remedial modules, bookmarking, progress bar, etc.)
- 4 Design an application interface that is aesthetically-pleasing, easy to use and navigate.
- 5 Develop an application user experience that is engaging and fun!

Target Audience

Kinundrum is primarily targeted for first-year kinesiology students in Dr. Judi Laprade's anatomy course to use as a supplementary learning resource. The assets within the e-learning application can also serve as teaching tools for Dr. Laprade and her teaching assistants to use during lectures or tutorial sessions.

Metrics for Success

Because *Kinundrum* is designed for Dr. Laprade's undergraduate anatomy class, we will focus on gathering qualitative feedback from Dr. Laprade, her teaching assistants, and current and previous students. Questionnaires and observations from informal prototype and user tests will inform the application development. Ultimately, the project's success will be evaluated both by the MRP Committee members, including BMC faculty and Dr. Laprade. Although beyond the scope of the MRP, there is potential for future quantitative user testing on the efficacy of *Kinundrum* to enhance anatomy learning as the first example of a problem-based multimedia e-learning application.

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Functional Specifications

CORE FUNCTIONALITY

Solve case studies by completing interactive modules. Interactive components include:

- submitting answers for the following question types,
 - multiple choice (select only one answer)
 - check boxes (select all that apply)
 - match answers
 - click and select answers
 - user text input
- selecting the correct illustration, animation or element within a 3D model
- dragging labels to match with illustrations
- dragging elements within an illustration
- watching animations with video player functions:
 - play/pause
 - rewind/forward
 - mute/unmute
- exploring 3D models with navigational functions:
 - freehand rotate
 - reset view
 - rotate using preprogrammed views
 - zoom in and out of model
 - hover over for labels

Unlock more challenging case studies

LEARNING FUNCTIONALITY

Keep track of progress while completing a case study

Access case study animation for review at any time

Create and **access** personalized notes about case study

Access hints and prompts when needed

Review the problem solving process once a case study has been completed

Bookmark completed modules for review

Access, search and **sort** bookmarked/completed modules

GENERAL FUNCTIONALITY

Built as downloadable software for desktop and tablets

User progress is saved/reloaded locally

Navigational user interface with access to:

- Home page
- Learning goals and tutorial
- Library of bookmarked/completed modules
- Settings

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Technical Specifications

Adobe Photoshop
Adobe Illustrator

2D Illustrations and Diagrams
UI Wireframe
UI Graphic Icons

Zbrush
Autodesk Maya

3D Models

Adobe AfterEffects
Toon Boom Harmony

Animations

Programming

HTML, CSS, JS files

Content Requirements

The following assets will be created or acquired in collaboration with Dr. Laprade:

- Application logo
- Landing/introductory page content (learning goals, text)
- In-application tutorial text
- UI graphic icons
- Case study questions, answers, hints, and correct/incorrect feedback
- Case study introduction and conclusion animations and scripts
- Case study module assets:
 - 2D illustrations
 - 3D models of hip, knee, leg, ankle and foot
 - 2D/3D animations
 - Potential live videos with motion graphics
- Flowchart showing problem-solving process

For more detail, please refer to the Appendix B. Visual Assets List.

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The user personas listed below are primarily first-year undergraduate students in the kinesiology program. We created these student personas based on feedback from Dr. Laprade, as well as her ICK tutorial and lab TAs. The personas were generated using learning type and skill criteria, such as whether they are surface or deep learners, and have low or high visuospatial abilities. Additional traits include their level of interest and study methods.

The following are applicable to all user personas

- First-year undergraduates at U of T
- Pre-PT
- Motivated to do well
- Kinesthetic/visual learners
- Generation Z (tech-savvy), ages 18-20



PRIMARY PERSONA

Tracy (who tries)

*“Anatomy is so hard!
There’s too much information to memorize.”*

Personality and Characteristics

- Surface learner
- Low visuospatial ability
- Detail-oriented, hardworking student
- Anxious about grades
- Type A

User Goals

- Learn and understand key concepts in anatomy
- Practice how to approach and solve case study problems
- Gain strategies on how to effectively learn and study anatomy

Tracy is a hardworking student who is struggling in anatomy. Although she finds Dr. Laprade’s lectures very interesting, she is so overwhelmed by all the material she needs to know. After each class, she carefully re-writes her notes several times, and laboriously reviews several stacks of flashcards. However, she finds the work she’s putting into memorizing is not helping her understand the material.

Tracy can list specific names of bones and muscles and nerves in the lower limb, but she always forgets what these structures look like and has a lot of difficulty linking the name of the structure to its function. When she consults Grant’s Atlas, she gets overwhelmed by the complexity of the images and distracted by details such as the shapes of the muscles.

During her peer group ICK tutorials, she usually has no idea where to begin and ends up relying heavily on her classmates to solve the case study problems. She is frustrated about her lack of contribution in the group, but too embarrassed to reach out to the TAs or Dr. Laprade for extra help.

As the upcoming exam draws closer, Tracy is feeling increasingly stressed. Recognizing that her current approach isn’t working, Tracy would love a resource that teaches her how to effectively study anatomy. Specifically, she would like to be able to practice the steps to solving a case study problem on her own time, without the added stress of peers who are faster than her. Feeling discouraged by the available resources, she is looking for visuals that are simple and easy to understand. Finally, Tracy wishes she could somehow monitor her anatomy knowledge so she can determine how much more studying she needs to do get a good grade.

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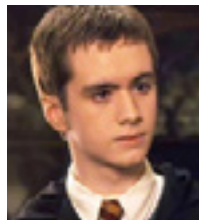
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SECONDARY PERSONA

Luke (who loves anatomy)

“I love the lectures and labs, but I wish there were more ways I could test my knowledge.”

Personality and Characteristics

- Deep learner
- High visuospatial ability
- Studies regularly
- Eager to learn

User Goals

- Practice applying his knowledge to case study problems
- Test himself to know whether he understands the material
- Review the material before the exam

Luke is an enthusiastic first year who absolutely loves anatomy. Luke usually goes to the library after class to review his notes, cross-reference with Grant’s Atlas and then summarize that information into his own words. Luke is comfortable with the lecture material but needs more resources to allow him to apply his knowledge to real-life examples. Currently, the only opportunity for him to problem-solve is during the weekly tutorial held by FEAT leaders. He enjoys working with his peers, but they can be distracting. He would like to see if he can complete a case study on his own.

Luke would like an application that presents musculoskeletal anatomy (hopefully free!) in context and allows him to test his knowledge while he is at home. He likes quiz-type apps because they are engaging and more fun. He has always enjoyed learning by doing rather than passively reading the textbook.



SECONDARY PERSONA

Polly (the parrot)

*“Is this on the exam?
OK, what’s the best (and most fun) way to learn it?”*

Personality and Characteristics

- Surface learner
- Low visuospatial ability
- Not interested enough to put in real effort
- Finds most learning resources dull
- Outgoing and enjoys collaborating

User Goals

- Get higher than 60% on her exam
- Understand structural relationships, function and dysfunction
- Have fun learning anatomy

Polly knows that a solid understanding of anatomy is essential to becoming a PT, but she finds the lectures slides a little boring, the textbooks overwhelming and online resources unengaging or irrelevant. YouTube videos are fun but don’t always cover the content that Dr. Laprade teaches. She is also an international student who lives in residence. Even though her English is quite good, some words are still unfamiliar to her so she uses her translator from time to time. The problem is she finds the slides and textbooks boring so she quickly loses interest.

Polly likes the ICK tutorials because she gets to work with her friends. She’s pretty good at identifying muscles and bony structures. After that, her friends take over because they understand functional relationships better than she does. She can see these structures in her head, but can’t visualize how they interact to produce movement. Innervation is even more complicated. Polly wishes there was some kind of learning resource available that is free, easy-to-use and engaging.

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SECONDARY PERSONA

Omar (the overachiever)

“Anatomy is very interesting but I wish I had more time to study :(:”

Personality and Characteristics

- Deep learner
- High visuospatial ability
- Procrastinator (he is ambitious and has too much on his plate)
- Has trouble finding time to study for anatomy

User Goals

- Do well in the anatomy course
- Practice applying what he learned in lectures because he is unable to attend the ICK tutorials
- Review content and develop critical thinking skills while accommodating his busy schedule

Omar is elated to be a first-year student. He is excited about being in university and will sign up for every event and committee clipboard he encounters but has trouble committing enough time to study anatomy. He did well in high school, so he’s determined to do just the same in university. He enjoys Dr. Laprade’s class immensely. He has no difficulty identifying musculoskeletal structures, innervation and joint anatomy. He has a good understanding of structural relationships, and how it affects movement and function. When it comes to solving case study questions, however, he is not confident on how to approach the problem. Because of his busy schedule, he is unable to attend some of the ICK tutorials and is therefore not familiar with the PBL process.

Omar is always on the go, but he reviews his lecture notes when he can. What he could really use is something convenient and mobile that can help him review anatomy, allow him to apply what he has learned, and ultimately develop his critical thinking skills.



SECONDARY PERSONA

Hans (the hotshot)

“High school biology was so easy. I’m sure anatomy will be a piece of cake.”

Personality and Characteristics

- Surface learner
- High visuospatial ability
- Feels very confident about doing well in anatomy
- Doesn’t study regularly because he feels he doesn’t need to
- Doesn’t know how to study effectively

User Goals

- Ace the anatomy course
- Learn how to study and review anatomy
- Find out which topics he struggles with and fill in his knowledge gaps

Hans feels like he is going to ace anatomy. Having previously aced exercise science in high school with minimal effort, he feels like he’s a step ahead of everyone else. His confidence is boosted when he realizes he is already familiar with most of the anatomical vocabulary presented by Dr. Laprade. Writing the midterm, however, was a brutal wake-up call for Hans. Despite his familiarity with the material and general understanding of the concepts, Hans struggled to apply his knowledge to answer the test questions. Surprised and frustrated, Hans barely got a passing grade.

Hans needs a learning tool that allows him to identify and resolve his knowledge gaps. Specifically, Hans would like a way for him to actively review and test his anatomy knowledge in different contexts.

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USING THE APPLICATION ALONE FOR THE FIRST TIME

“TRACY” PERSONA

BACKGROUND

Despite reviewing lecture notes and assigned reading before the ICK tutorial today, Tracy had no idea how to even start approaching the case study problems on leg anatomy and felt useless in her peer group. At the end of the session, Dr. Laprade mentions *Kinundrum*, an optional e-learning app for case study problems, and Tracy jumps at the chance to give it a try.

- 1 After coming back to her dorm room that afternoon, Tracy downloads the application from the class page on Blackboard onto her laptop. Often intimidated by new software, she is relieved to see that when she opens the application, there is a tutorial to guide her through the main controls.
- 2 Tracy clicks on a lower level case study to start. She watches a short, entertaining case scenario animation on a person with a limp. As prompted by the app, she types up the main points in the notebook feature next to the video, re-watching and scrolling through the video several times to get all the important information. After she decides to move one, she notices the animation and notes are placed in a ‘patient folder’ feature that she is able to re-access at any point.
- 3 The first question asks her to identify the plane of the affected movement. She consults the GIF animations accompanying the question and clicks to answer. She is rewarded with victory sounds, which make her feel successful. She also notices that the first bubble in the progress bar is now highlighted. Great! Tracy is happy she can track her progress through the case study.
- 4 The next question is accompanied by a 3D model. Tracy clicks and drags with her mouse to rotate around the model. When her mouse hovers over strings, she sees that labels appear, identifying the muscle. Oh neat! She realizes the strings on the muscle represent muscle. Tracy is able to understand the anatomy in the simplified model, but she doesn't know the answer and guesses.
- 5 Tracy sees a message notifying her that her answer is not right, and asked to abduct her leg to mime the movement in the question. When Tracy lifts her leg and consults the 3D model once more, she realizes which muscle must be the correct answer. Indeed, she is rewarded with victory sounds when she clicks to answer. Tracy makes a note to use this problem-solving approach in the future.
- 6 Tracy also gets the third question on ligaments wrong. This time she is directed to another module with an interactive diagram. Guided by instructions on the page, Tracy clicks to drag the femur relative to the hip joint. She can see different ligaments stretching to limit a particular movement depending on which direction she moves the femur. Cool, she can visualize the functions of each ligament! Tracy takes her time, slowly goes over each ligament in the diagram. She decides to bookmark this module so she can review these ligaments again later.
- 7 After an hour, Tracy decides to save her progress and exits the app. Even though she only finished three questions, she feels like she learned a lot. Seeing the three bubbles highlighted in the progress bar makes her feel especially accomplished. She decides that she will start using the app regularly to both learn and review anatomy.

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REVIEWING A SECOND TIME WITH A FRIEND
“TRACY” PERSONA

BACKGROUND

It's only a week away from the anatomy final, and Tracy is knee deep in studying. She has been slowly making her way through the Kinundrum case study modules. She has unlocked all of them except the most difficult module. Feeling like a change from studying by herself, she sets up a study date with her classmate Julia to go through it together.

- 1 After watching the case study video, laughing at the cute animation and graphics, they take turns listing the important symptoms and information to type out in the notebook feature. Before they even start on the first question, they briefly talk about what their problem-solving approach would be to solve the problem as a whole.
- 2 Right away, they notice that the question in the most difficult exercise aren't accompanied with problem solving tools such as illustrations or 3D models. They are prompted to rely on their anatomy knowledge and mental map to solve the questions.
- 3 For the first couple questions on skeletal and muscle anatomy, Julia and Tracy are able to talk out the answers correctly. For one question on ligaments, Tracy visualizes an interactive diagram she remembers from a previous remedial module to identify the structure.
- 4 The question on nerve anatomy, however, stumps them. Instead of guessing to move on, however, they decide to access the hint feature, which reveals the relevant 3D model. Rotating this model around, they are able to figure out the correct answer. Tracy bookmarks this model so that she can make sure she can visualize it in her head before the exam.
- 5 At the end of the case study, Julia and Tracy watch the conclusion video, which highlights the main takeaways. They also look at the flowchart which maps out the question breakdown to review their problem-solving approach.
- 6 After finishing the case study, they reset some of the previous case studies and do them again to make sure they understand the concepts. Instead of reading the feedback for each question carefully, they whiz through them and mostly rely on the review animation and bulleted points at the end of the case study to confirm their results.
- 7 Using the diagrams and 3D models they've bookmarked, Julia and Tracy spend some time quizzing each other. Because they are able to hide the labels and move the muscles and bones relative to each other, they can ask each other a variety of questions on anatomy identification and function.
- 8 After a couple hours, they decide to grab dinner. Tracy feels happy that the review session was so productive. She is confident for her upcoming exam.

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USING THE APPLICATION AT HOME

“LUKE” PERSONA

BACKGROUND

After a long day of class, Luke decides to study some anatomy. He recalls Dr. Laprade presenting a new learning resource available on Blackboard. Using his laptop, he clicks on the link to download *Kinundrum*.

- 1 After downloading, Luke launches the application and is met with a screen explaining the learning goals of the application. He briefly reads over them. He is then met with two options: Home and Tutorial. Dr. Laprade went over the tutorial already so Luke feels comfortable skipping it.
- 2 Once at the home page, Luke is presented with different case studies. They have fun topics but do not specify the joint. He clicks on one that is unlocked for the time being. Here, he is presented with a short animation of a patient hurting their knee playing soccer. That’s cool! Luke also plays soccer. In the video, he is able to see the mechanism of injury. Once the video is done, Luke chooses to move forward and the video is filed into a patient folder.
- 3 He breezes by the first questions addressing basic knowledge. However, he thinks they did serve as a good reminder. As he goes through the questions, he finds himself having to constantly consult different parts of his notes.
- 4 Occasionally, Luke gets a question wrong because he reads it too quickly. Fortunately, the app will highlight keywords in the question and gives hints before letting him try again. He can also open definitions as he hovers over the highlighted keywords. The hint button gives prompts such as “use your elbow to replicate the motion”. He also enjoys the testing format because it keeps him more engaged than readings and reviewing lectures.
- 5 Luke reaches a question that is accompanied by a remedial module. He explores the remedial module by clicking on the book icon beside the question. It is an interactive activity that showcases ligament tension. Luke hasn’t experienced any resource that would allow him to visualize the body in such a way.
- 6 Many times, Luke is between answers and ends up guessing between the two. If he answers correctly, the app will explain why his answers are correct or incorrect. This allows him to gain a greater understanding of the problem.
- 7 Luke is a big fan of the interactive 3D models in the app and saves them for later studying by pressing the bookmark button. He can access these bookmarked modules at any time.
- 8 Finally, Luke has reached the last question where he is asked to put together the entire problem in context. He has access to all his previous answers to help him piece together the case study diagnosis. Once he has answered, he is brought to a page with the conclusion animation, a flow chart detailing the problem breakdown to show him what path he has taken to reach his answer as well as a summarized list of the study. At the bottom of the page, there are more open-ended questions that encourage Luke to further explore aspects of the case study.
- 9 Luke has successfully finished the first case study. He enjoyed the experience because it allowed him to apply the class material in a clinical context, instead of repetitively reviewing theory. He closes the app and gets some well-deserved ice cream.

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USING THE APPLICATION TO REVIEW FOR AN EXAM**"POLLY" PERSONA****BACKGROUND**

It's the weekend before the exam and Polly is in a panic. She has been reviewing her lecture notes, and memorized all the muscles and movements but still doesn't understand how the joints, bony structures and direction of muscle fibers result in these movements. Her friends are all home for the weekend so she is on her own. She turns on her laptop to visit UofT's Blackboard portal. Maybe Dr. Laprade posted links to other resources Polly hasn't checked out yet. She recalls Dr. Laprade talking about *Kinundrum*, a helpful case study application, so she clicks on the link to start the download.

- 1 The app opens with the learning goals which she quickly reads over. As she goes through the tutorial, she is immediately attracted to the app's gaming format. She likes that she has to unlock modules to be able to attempt the most difficult case study. Polly is a video gamer so the app configuration feels comfortable. After the tutorial ends, she starts with the first case study.
- 2 This app is pretty cool! The case study is introduced with a fun animation. She also notices that the narration is accompanied by written text highlighting the major points. The animation has a pause button which she uses when she encounters a word or phrase that she doesn't quite understand. She enters the written text into the translator app on her phone then hits play again to continue the animation.
- 3 When the animation ends, the video slides into the patient folder. She guesses that she is able to watch it again if she needs to. She begins exercise 1, and is relieved that the module is not timed. She can take her time understanding the question.
- 4 The first exercise asks her which ligament will be strained for each ankle position illustrated. In her head, she identifies the ligaments, and locates where they originate and insert, but beyond that she's stumped. She clicks on the Hint button, and it asks her to move her own ankle to determine which ligaments are being stretched. She selects her answers and hits submit. She is greeted with a victory sound, and a green check mark appears on the first exercise of the progress bar. She is pleased and moves on to the next exercise.
- 5 The second exercise asks her to identify which muscles would be affected by the ankle sprain and is accompanied by a rotatable 3D model. How fun! She gets excited and starts to rotate the model around. Now she has rotated and zoomed into an unrecognizable angle. She clicks on the reset button and the model goes back into the original view point. Instead of rotating the model itself, she uses the arrows to rotate it into preprogrammed angles. When she mouses over muscles, they are highlighted but not labeled. Hmm, that makes this exercise a little trickier. She clicks on the first Hint, and it asks her to identify the ligament affected first. She consults the case study video again, and makes her choice. The ligament remains highlighted on the model. She clicks on the second Hint, and it asks her if she wants to turn the labels on. Now, when she mouses over muscles, labels pop up identifying each. She selects one muscle and hits submit.
- 6 A pop-up window appears telling her that her answer was not quite right. It tells her that more than one muscle is affected. It gives her other helpful prompts like thinking about which muscles are activated and which muscles are antagonistic to it. She likes that there is a link to review Dr. Laprade's slides, but she is confident about her answer, so she clicks the button that says, "I got this!".
- 7 She selects the second muscle on the 3D model and hits submit. Yes, it's correct! A green check mark appears on the progress bar, and she has reached the end of this module. She watches the conclusion animation, and likes that the key take-away points are summarized next to it. She bookmarks this page because she knows this will be useful to review closer to exam time.
- 8 This app turns out to be pretty fun. Polly is determined to unlock all levels, so she eagerly moves on to another case study.

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USING THE APPLICATION ON THE GO "OMAR" PERSONA

BACKGROUND

The exam is coming up and Omar feels unprepared. He has attended lectures and labs but hasn't had time to review his notes. He really regrets taking on a full course load this semester, and joining the varsity swim team on top of that! But he's determined to do well in anatomy. After going through his lecture notes once, he remembers the application Dr. Laprade recommended to the class. Trying out another learning resource isn't a bad idea, so he gives *Kinundrum* a go.

- 1 He logs on to the UofT Blackboard portal and downloads the application onto his iPad. As the application loads, he organizes his lecture notes and places it next to him so he can refer to them if he has to. The application opens up to a page with a list of learning goals. He reads them and makes a mental note that they are similar to Dr. Laprade's course goals.
- 2 The app suggests doing the tutorial but Omar feels it'll be a waste of time. Besides, he's familiar with video games, how complicated could this be? So he skips the tutorial and moves on to the lower limb joints.
- 3 He starts with the first case study. After an animation of the problem, he dives right into exercise 1. He answers everything correctly and is feeling pretty good. He moves on to the next exercise and is unfamiliar with the activity. He decides to go back to the menu and go through the tutorial after all. After he finishes his tutorial, he realizes he's late for swim practice. He puts his iPad to sleep and puts it in his backpack.
- 4 On the bus, he takes out his iPad and continues the hip joint module. His progress was saved, so he continues completing exercise 2. He moves on to exercise 3 and has difficulty answering the question. He realizes he has forgotten his notes back home. He clicks on the case study icon to watch the animation again. He's unsure but he picks the option that seems most correct. Oh no, it's incorrect! A hint is given but even with that, he's still not sure. So he clicks on the "I need to review" button, and Dr. Laprade's lecture slides open. He reviews the lecture slides and figures out the answer. He submits his answer, and is rewarded with a victory sound. That was a tough one! He bookmarks the module so he could try it again another time. He feels more confident about continuing so he moves on to the next exercise.
- 5 He's almost at his stop so he checks the progress bar to see how many exercises are left. He's got one more to go so he pushes on. Once he completes the last exercise, a conclusion animation plays. It explains why the patient's dysfunction is occurring, while simultaneously listing down the key take-away points. That's good to know! He bookmarks this module to review again later.
- 6 He's at his stop. He goes to swim practice feeling a little relieved knowing that he has finished the hip module. He decides to move on to another case study after swim practice during his bus ride home.

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USING THE APPLICATION TO LEARN HOW TO STUDY**"HANS" PERSONA****BACKGROUND**

Hans can't believe it. He got 58% on his midterm! He's frustrated and upset because he had gone into the exam feeling so confident. He memorized all the structure names, took stellar notes and spent hours watching YouTube videos to help him prepare for the exam. So identifying structures was no problem for him, but when it came to the case study questions, he blanked out. He underlined the names that he recognized, but that was as far as he got. He really wants to do better. What is his study approach lacking and how can he fix it? He sees Dr. Laprade during her office hours in search of hope (cue god rays). Dr. Laprade recommended *Kinundrum*, a learning application. He downloads it on his iPad immediately.

- 1 Hans quickly skims through the learning goals and tutorial. On the main page, he sees that there are a bunch of modules to choose from. Great, looks like there are a lot of exercises to practice with! He starts with one titled "The Case of the Tennis Mom" because the thumbnail looked interesting.
- 2 While watching the case study scenario, Hans easily picks out the important information to write in the notebook feature, which he can access throughout the case study.
- 3 Although he recognizes the key terms in the first question and is familiar with the illustrations that accompany it, he doesn't know how to answer it. He'd rather not have to ask for hints but he presses the Hint button reluctantly anyway. The hint asks him to recall the structures in the area, and move his ankle around. Oh DUH, why didn't he think of that. He does it and notes which ligaments are being pulled. He matches the ligaments to the ankle position, and hits the submit button. He's correct! He thinks that maybe checking the hints might not be so bad after all since helpful prompts are given.
- 4 The next question asks what type of movement affects the injury. He recalls what type of movements are produced in the ankle. He's got this one for sure, so he submits his answer. It's incorrect! But instead of moving on, he is directed to another model. He follows the instructions and clicks to move the ankle into different positions. He realizes that he didn't actually understand the ankle movements like he thought. He bookmarks this module to review again later. He re-evaluates his answer, and hits submit. Phew, it's correct! He checks the progress bar and sees that he has one more question in this case study.
- 5 The last question asks him which of the muscles involved in plantar flexion are the two most dominant. He recalls seeing a table in a textbook which lists the muscles on one column and relevant functions on the next column. He recognizes all the plantar flexor muscles listed as options. He selects the two that he is most familiar with. Oh man, he's incorrect again. A hint pops up that reminds him of the 'rule' of muscles. He remembers Dr. Laprade going over this in class. He changes his answer and hits submit. He's correct! And another window opens with an illustration of the superficial and deep layers of the ankle. The app offers this module for him to review, so he looks over it quickly now, and bookmarks it for later.
- 6 He got through the case study! He got answers wrong more often than he thought. For Hans, the app was particularly useful as a diagnostic tool to point out his knowledge gaps and weaknesses. The flowchart at the end of the case study is particularly useful as it shows him what the problem solving process was like. He tries out the rest of the case studies, and uses the hints to help him along the way.

5 TIMELINE

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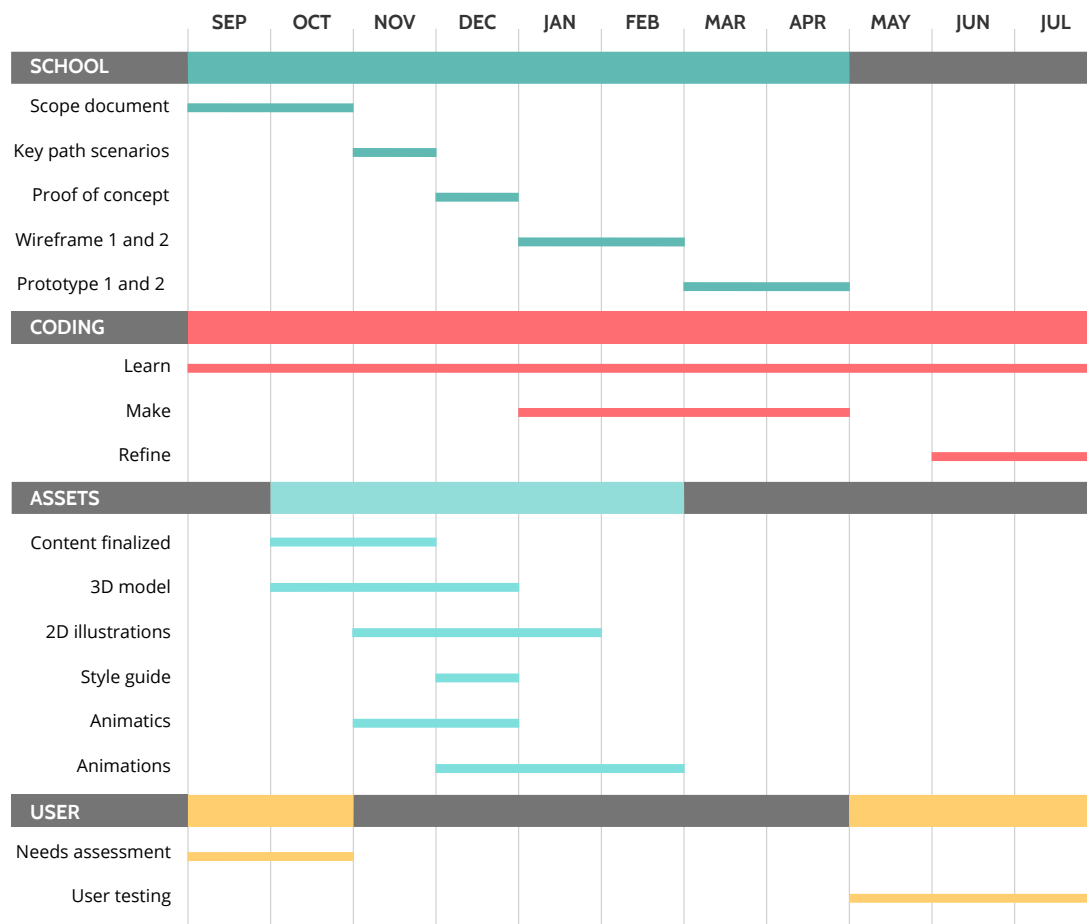
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A. DESIGN REQUIREMENTS (IN DETAIL)

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| | Functional | Content | Data type | Instances |
|-------------------------------|--|---|--------------|---|
| Splash screen | | | | |
| | View the animated logo | Animation of logo, logo | 2D animation | Splash screen |
| | Hear the app theme jingle | App theme jingle | Audio file | Splash screen |
| Menu/Navigation | | | | |
| | Access the: 1. home page 2. learning goals and tutorial (introduction screen) 3. library of bookmarked modules 4. settings | Icons for: 1. home page 2. learning goals and tutorial (introduction screen) 3. library of bookmarked modules 4. settings | Icons | Always available throughout application |
| | Show/hide the progress bar (as user goes through case study) | Icon for progress bar | Icons | Available within a case study |
| | Access case study exercises via the progress bar (available only when entire case study has been completed) | Graphic identifying each exercise (eg. circle with number) | Icons | Available within a case study |
| 1. Home screen | | | | |
| | Read and select the case studies (names and icons) | Titles and graphic for each case study | Text, icons | Home screen |
| | Show/hide the completed progress for each case study | Graphic showing the progress for each case study Titles for exercises within each case study | Text | Home screen |
| 2. Introduction screen | | | | |
| | Read the learning goals | Learning goals for app | Text | Introduction screen |
| | Access the tutorial (2.1) | Icon for tutorial | Text, icon | Introduction screen |
| | Access the home page (1) | Icon for home page | Text, icon | Introduction screen |
| 2.1 Tutorial module | | | | |
| | Watch sample case study scenario (rewind, fast forward, scroll, pause, play) | Tutorial animation | 2D animation | Available in the tutorial module |
| | Read the sample case study question, answer, correct/incorrect feedback | Tutorial sample question, answer, correct/incorrect feedback | Text | Available in the tutorial module |
| | Read the tutorial prompts | Tutorial prompts | Text | Available in the tutorial module |
| | Watch the tutorial motion graphics (pointing arrows, highlighting bars) | Tutorial motion graphics | Graphics | Available in the tutorial module |
| | Access the home page after tutorial is completed | Icon for home page | Icon | Available in the tutorial module, or via menu |

A. DESIGN REQUIREMENTS (IN DETAIL) CONTINUED...

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| | Functional | Content | Data type | Instances |
|---|---|---|---|-------------------------------|
| 3. Library | | | | |
| | Access completed and bookmarked modules | Link to each module | Text, icons | Library |
| | Sort modules by name, joint, media type, or bookmarked (eg. all hip modules, all 2D interactive modules) | Modules | Name Joint Media type Order of user preference | Library |
| | Search through modules | Search bar | Text, icons | Library |
| | Bookmark/unbookmark modules | Check boxes | Check boxes | Library |
| 4. Settings | | | | |
| | TBD | TBD | TBD | Settings |
| Within Case Study Modules | | | | |
| Introductory video module and Patient Case Folder | | | | |
| | Watch case study scenario Video player functions: - play/pause - rewind/forward - mute/unmute | Case study animation, narration | Animation, audio file, buttons for video player functions | Available within a case study |
| | Read case study scenario narration | Case study narration | Text | Available within a case study |
| | View, edit, input notes | Notebook page within case folder | User text input | Available within a case study |
| | Show/hide case folder | Icon to show/hide case folder | Icon | Available within a case study |
| Question Types | | | | |
| <i>*Note: Numbers correspond to specific exercises in the case study modules.</i> | | | | |
| Multiple choice (only one answer) | | | | |
| | Read questions and choices | Questions, choices | Text, circle to select choice | |
| | Select the correct 2D illustration | H1.3: 2D gait stills from the introductory animation A2.1: deep and superficial illustrations of ankle | 2D illustration | H1.3, A1.2 |
| | Drag elements in a 2D illustration | K1.3: illustration of tibia, femur, ligaments | 2D illustration | K1.3 |

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| | Functional | Content | Data type | Instances |
|---|---|--|---|------------------------|
| Multiple choice (only one answer) (continued...) | | | | |
| | Select the correct gif/ animation | H1.1: animations of normal/abnormal gait in coronal plane, animations of normal/ abnormal gait in sagittal plane H1.2: animations of hip, knee, ankle joint during gait cycle, right or left side H1.5: animations of gluteus medius and minimus during eccentric and concentric contraction A2.2: animations of the ankle during different types of movement | Animation | H1.1, H1.2, H1.5, A2.2 |
| Check boxes (select all that apply) | | | | |
| | Read questions and choices | Questions, choices | Text, box to select choices | |
| | Freehand rotate the 3D model to explore the anatomy | A2.3: model of the muscles of the lower leg | 3D model | A2.3 |
| | Reset view | Preprogrammed original view | 3D model (reset button) | |
| | Rotate the 3D model using preprogrammed views | Preprogrammed views at incremental angle values | 3D model (arrow buttons) | |
| | Zoom in and out on model | A2.3: model of the muscles of the lower leg | 3D model (zoom buttons) | |
| | Hover for labels | A2.3: labels of muscles of the lower leg | 3D model, text | |
| | View illustration to answer correctly | A2.1 illustrations of superficial and deep layers of the ankle | 2D illustration | A2.1 |
| | Watch gif to answer correctly (no video player functions required) | K1.1: gif of knee being damaged K2.1: gif of kicking motion | Animation | K1.1, K2.1 |
| | Watch animation to answer correctly Video player functions: - play - pause - rewind - forward - mute/unmute | K2.2: animation of the leg preparing to kick K2.3: animation of the leg kicking | Animation, buttons for video player functions | K2.2, K2.3 |
| | Select the correct gif | K2.4: gifs of combinations of knee flexion/extension and hip flexion/extension K2.5: gifs of different daily activities | Animation | K2.4, K2.5 |
| | Submit answer once finalized | Submit button | Button | |

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| | Functional | Content | Data type | Instances |
|-------------------------|---|---|-------------------------------------|------------------------|
| Matching | | | | |
| | Read question | Questions | Text | |
| | View illustration to answer correctly | A1.1: illustrations of medial ankle (DF, PF, neutral) | 2D illustration | A1.1 |
| | Drag labels to corresponding illustration | Ligament names (ATP, PTF, CF) | 2D illustration (draggable textbox) | |
| | Submit answer once finalized | Submit button | Button | |
| Click and select | | | | |
| | Read question | Questions | Text | |
| | Select 1 or more structures on 3D model | H1.4: 3D model of the muscles of hip H1.6: 3D model of innervation of hip K1.2: 3D model of bony structures of knee A1.3: 3D model of the muscles of lower leg | 3D model | H1.4, H1.6, K1.2, A1.3 |
| | Freehand rotate the 3D model to explore the anatomy | | 3D model | |
| | Reset view | Preprogrammed original view | 3D model (reset button) | |
| | Rotate the 3D model using preprogrammed views | Preprogrammed views at incremental angle values | 3D model (arrow buttons) | |
| | Zoom in and out on model | Preprogrammed zooms at incremental values | 3D model (zoom buttons) | |
| | Hover for labels | H1.4: labels for muscles of the hip H1.6: labels for nerves of the hip K1.2: coloured aread for attachment sites at the knee A1.3: labels for the muscles of the lower leg | 3D model, text | |
| | Submit answer once finalized | Submit button | Button | |
| Type in | | | | |
| | Read question | Questions | Text | |
| | Type in answer | Textbox for user to type in | User text input | H1.7, A2.4 |
| | Submit answer once finalized | Submit button | Button | |

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| | Functional | Content | Data type | Instances |
|---|--|---------------------------------|---|---------------------------------|
| Conclusion Video Module | | | | |
| | Watch conclusion video Video player functions: - play - pause - rewind - forward - mute/unmute | Conclusion animation, narration | Animation, audio file, buttons for video player functions | Available in case study modules |
| | Read key take-away messages from conclusion video | Key take-away messages | Text | Available in case study modules |
| | Show/hide case study flowchart | Flowchart | Icon | Available in case study modules |
| | Bookmark case study flowchart | Flowchart | Icon | Available in case study modules |
| General Case Study module elements | | | | |
| Hints | Access and read the hint | Hint text | Text | Available in case study modules |
| Correct/Incorrect feedback | Read the correct/incorrect feedback | Feedback text | Text | Available in case study modules |
| Further review | Access Dr. Laprade's lecture slides | Lecture slides (in PDF format) | Link | Available in case study modules |
| Bookmark | Bookmark modules to access and review later | Module | Icon | Available in case study modules |

B. VISUAL ASSETS LIST

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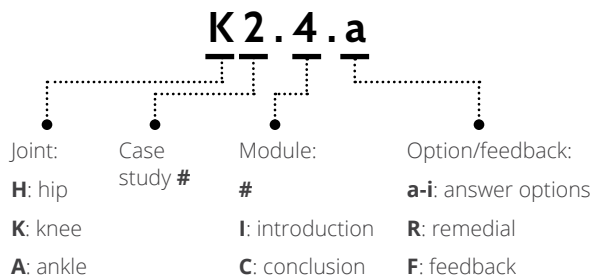
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A. Design Requirements (in detail)

B. Visual Assets List

The visual assets list is a working document. The current version lists content requirements specific to the case study modules and are organized by content type (animation, illustration or 3D model).

A naming convention was set to identify each asset according to joint module, exercise number, and module type. See legend on the right for an example.



ANIMATIONS

| Assets | Description | Instances |
|-------------------|---|------------------------------------|
| Hip Joint | | |
| Animation H1.I | Intro animation | Intro |
| Animation H1.1.a | Fred - coronal plane, normal gait | H1.1 |
| | | H1.2 |
| | | H1.3 (8 stills showing gait cycle) |
| | | H1.5 (mid-stance gif) |
| Animation H1.1.b | Fred - coronal plane, abnormal gait | H1.1 |
| | | H1.2 |
| | | H1.7 |
| Animation H1.1.c | Fred - sagittal plane, normal gait | H1.1 |
| | | H1.5 (mid-stance gif) |
| Animation H1.1.d | Fred - sagittal plane, abnormal gait | H1.1 |
| | | H1.3 |
| Animation H1.C | Conclusion animation - TBD | Conclusion |
| Knee Joint | | |
| Animation K1.I | Intro animation | Intro |
| Animation K1.1 | Zoomed in animation of Van Diesel's knee during the car accident (skin and bones) | K1.1 |
| | Anatomy X-ray vision: show knee with ligaments and muscles | K1.1 hint |
| | Anatomy X-ray vision: show knee with ligaments and muscles | K1.1 incorrect |
| Animation K2.I | Intro animation | Intro |
| | K2.1.F (show player's kick in slow motion) | K2.1 incorrect |
| Animation K2.1 | Animation of wind-up and kick phases (leg without muscles) | K2.1 |
| | Animation K2.1 but of leg with muscles (wind-up phase) | K2.2 |
| | Animation K2.1 but of leg with muscles (kick phase) | K2.3 |
| Animation K2.3.R | Review of eccentric and concentric movements | K2.3 remedial |

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| Assets | Description | Instances |
|--------------------|--|---------------|
| Animation K2.4.a | GIF of knee flexion, hip flexion | K2.4 |
| Animation K2.4.b | GIF of knee flexion, hip extension | K2.4 |
| Animation K2.4.c | GIF of knee extension, hip flexion | K2.4 |
| Animation K2.4.d | GIF of knee extension, hip extension | K2.4 |
| Animation K2.4.F | Animation of hamstrings contracted and stretched | K2.4 correct |
| Animation K2.5.a | GIF of picking something off the ground | K2.5 |
| Animation K2.5.b | GIF of climbing up the stairs | K2.5 |
| Animation K2.5.c | GIF of bending over with knee straight | K2.5 |
| Animation K2.5.d | GIF of running | K2.5 |
| Animation K2.5.e | GIF of sitting in a chair | K2.5 |
| Animation K2.5.f | GIF of figure four stretch | K2.5 |
| Animation K2.5.g | GIF of laying in a bed | K2.5 |
| Animation K2.5.h | GIF of standing | K2.5 |
| Animation K2.C | Conclusion animation - TBD | Conclusion |
| Ankle Joint | | |
| Animation A1.I | Intro animation | Intro |
| | GIF of ankle rolling | A1.2 |
| Animation A1.1 | 3 stills from animation: A1.1a (dorsiflexion + inversion) A1.1b (plantarflexion + inversion) A1.1c (neutral + inversion)" | A1.1 |
| | A1.1.R Animation of ankle in dorsiflexion and plantarflexion | A1.1 remedial |
| | A1.1.R Animation of ankle in eversion and inversion | A1.1 remedial |
| Animation A2.I | Intro animation | Intro |
| | GIF of affected walk | A2.2 |
| | GIF of tennis mom looking unhappy and holding her calf | A2.4 |
| Animation A2.2 | Animation of normal gait cycle | A2.2 |
| Animation A2.C | Conclusion animation - TBD | Conclusion |

Introduction animations: 5

Conclusion animations: 3

Short animations: 8

GIFs: 12

TOTAL ANIMATIONS: 28

B. VISUAL ASSETS LIST

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ILLUSTRATIONS

| Assets | Description | Instances |
|---------------------|--|----------------|
| Hip Joint | | |
| Illustration H1.4.F | H1.4.F Illustration (diagram of ¾ view of hip and thigh, with arrow showing lifted hip movement) | H1.4 incorrect |
| Flowchart H1.C | Problem solving process | Conclusion |
| Knee Joint | | |
| Illustration K1.3 | Knee and ligaments | K1.3 |
| (animated model) | K1.3.F Animation of PCL function | K1.3 correct |
| (animated model) | K1.3.R Animation of knee and ligament illustration showing sliding animation with explanation | K1.3 remedial |
| Flowchart K1.C | Problem solving process | Conclusion |
| Flowchart K2.C | Problem solving process | Conclusion |
| Ankle Joint | | |
| Flowchart A1.C | Problem solving process | Conclusion |
| Illustration A2.1.a | Superficial layer of anterior leg | A2.1 |
| Illustration A2.1.b | Deep layer of anterior leg | A2.1 |
| Illustration A2.1.c | Superficial layer of posterior leg | A2.1 |
| Illustration A2.1.d | Deep layer of posterior leg | A2.1 |
| Flowchart A2.C | Problem solving process | Conclusion |

| | |
|-------------------------------|-----------|
| Illustrations: | 6 |
| Animations from illustration: | 2 |
| Flowcharts: | 5 |
| TOTAL ILLUSTRATIONS: | 11 |

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3D MODELS

| Assets | Description | Instances |
|-----------------|--|---------------|
| Hip Joint | | |
| 3D model H1.4 | Model of Fred's hip, deep and superficial muscle layers. Must show: Gluteus maximus Gluteus medius Gluteus minimus Iliopsoas Rectus femoris Hip adductors | H1.4 |
| | Model of Fred's hip, innervation. Must show: Superior gluteal nerve list other nerves | H1.6 |
| (animate model) | H1.4.F Animation of gluteus medius and minimus contracting to lift the hip on the contralateral side | H1.4 correct |
| (animate model) | H1.5.R Animation - student clicks on muscle to activate gluteus medius and minimus to see movement produced; simplified overlaid diagram of hip | H1.5 remedial |
| Knee Joint | | |
| 3D model K1.2 | Model of Van Diesel's knee | K1.2 |
| Ankle Joint | | |
| 3D model A1.3 | Model of the leg, deep and superficial muscle layers | A1.3 |
| 3D model A2.3 | Model of leg and ankle | A2.3 |

Models: 4

Animations from models: 2

TOTAL 3D MODELS: 4