Ankle Rehab

Instructional System Design

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Rehabilitation exercise programs are an important part of recovery for patients who have experienced ankle trauma. However some patients are not motivated to complete the rehabilitation or may do the exercises incorrectly. The purpose of this project is to develop a video game that will teach ankle rehabilitation exercises and motivate patients to complete them on schedule. The game will involve mapping rehabilitation exercises to game mechanics (ie: flexing an ankle = shoe sword fighting) and then providing accurate feedback to correct rehabilitation errors (ie: incorrect exercises = losing a match). Because rehabilitation builds on itself, naturally progressing from slow, basic movements to a more active and complex sequence of movements, our game will have to scaffold itself to include early exercises as the basis for more advanced ones. The main audience for this video game is patients who who have sprained or twisted an ankle badly enough to need to rest it for at least a day.

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Section 1: Desired Results

1-A Big Ideas and Broad Goals

Minor ankle twists and sprains are some of the most common injuries people experience. Because the treatments for these injuries are often misunderstood, they can fail to fully heal, leading to increased risk of repeated ankle twists and sprains for the patient. Even when patients know the correct rehabilitation procedure, it can be hard to stick to the exercise regimen once mobility is regained. Often the business of living life causes patients to skip exercises sporadically or quit the rehabilitation altogether. We would like to develop a video game that could offer a solution to all these problems.

Using the Kinect with the XBox 360 or Windows PC, we can detect body position and muscular movements, as long as they aren't extremely fine motor skills (e.g. surgical cutting and stitching). By comparing the patient's body position and muscular movements to the standards for a given exercise, our video game will be able to tell if the patient is doing an exercise incorrectly, and if so can provide appropriate feedback. Each exercise will be scaffolded according to difficulty and its place in the rehabilitation procedure. We also hope to create a fun, possibly social environment, which will motivate patients to continue the exercises.

Goal 1: Patients will understand the full scope of ankle rehabilitation from incurring the injury to being fully healed.
Goal 2: Patients will be able to perform all of the rehabilitation exercises correctly.
Goal 3: Patients will be motivated to continue the rehabilitation until completion.

1-B Learning Objectives

Goal 1: Patients will understand the full scope of ankle rehabilitation from incurring the injury to being fully healed.

Objective 1.1: After completing the video game, patients will be able to recall the rehabilitation process with 90% accuracy.
Objective 1.2: After completing each exercise, patients will be able to state their current limitations (e.g. can't run on it, or needs to be elevated at night)

Goal 2: Patients will be able to perform all of the rehabilitation exercises correctly.

Objective 2.1: After reading the step-by-step instructions provided with the game, the patient will be able to set up the Kinect sensor with their Windows PC or XBox 360 console without encountering any error messages.

Objective 2.2: After seeing a demonstration on their television and practicing each rehabilitation exercise with coached feedback, the patient will be able to perform the correct body position and muscular movements in front of the Kinect with 90% accuracy.
Objective 2.3: After using the rehabilitation game for a period of one week, the patient will be able to perform the correct body position and muscular movements in front of their doctor or physical therapist with 90% accuracy.

Goal 3: Patients will be motivated to continue the rehabilitation until completion.

Objective 3.1: Given a series of exercises, the patient will perform each for the recommended number of repetitions with 90% accuracy.
Objective 3.2: After completing each exercise, patients will be able to state the purpose of each exercise with 100% accuracy.
Objective 3.3: Given a weekly schedule of exercises that updates based on progress toward full rehabilitation, the patient will complete recommended exercises at least 4 days out of the week to meet rehabilitation goals.

1-C Needs Assessment

Types of Information	What do you need to know?	Why do you need to know this?	Information Sources	Types of Procedures (Instruments)
Optimals	What ankle exercises should participants perform? How often and how long should each exercise be performed? Where should exercises be performed? (at home, in the doctor's office, etc)	To identify a skills/knowledge gap or other gap (such as one with environmental or motivational causes), we first need to become familiar with the content and expected behavior.	Dr. Aaron Gray	Personal Interview

Actuals	How well do participants understand and perform ankle exercises? How often and for how long do participants typically work on rehabilitation exercises? What relevant technology and equipment do participants have access to?	We need to determine actual behavior (exercise completion rate and accuracy) in order to compare this to optimal results and determine the gap. We also need to find out whether participants have access to a Kinect or other technology that could be utilized in possible solutions.	Dr. Gray Other doctors and therapists that deal with ankle rehabilitation cases Patients who have gone through ankle rehabilitation	Personal Interview Voluntary survey doctors and therapists can distribute to their patients
Feelings	How important do participants believe the exercises are? How interesting do participants find the exercises? How much difficulty do participants have using new technology such as Kinect games? How interesting do participants find new technology such as Kinect	We need to determine the level of excitement or resistance toward these exercises and toward games as a possible solution.	Patients who have gone through ankle rehabilitation	Voluntary survey doctors and therapists can distribute to their patients

	games?			
Causes	What are the primary reasons for not keeping up with exercises as scheduled? What are the primary reasons for carrying out an exercise incorrectly?	We need to find out whether the causes are skills/knowledge- related (due to not remembering or understanding the exercises), motivational (not caring about the exercises), environmental (not having the time or equipment necessary), or some combination of these causes.	Dr. Gray Other doctors and therapists that deal with ankle rehabilitation cases Patients who have gone through ankle rehabilitation	Interview Voluntary survey doctors and therapists can distribute to their patients
Possible Solutions	How could a Kinect game keep participants on target? How could a Kinect game evaluate the accuracy of movements and provide coaching?	We need to understand the technical capabilities and design needs for this solution. We also need to assess whether this type of solution will address the problem effectively.	Studies, Articles, XBox360 / Kinect website, Volunteer programmers	Brainstorming Session

1-D Task Analysis

Our development team performed a task analysis by thoroughly examining the entering capabilities of the users as well as other prerequisites, topics, and procedures. Our analysis focuses on the setup and use of the Kinect with the XBox 360 or PC, the types of ankle injuries treated by the game, and the types of exercises used for rehabilitation. Our prerequisite analysis, found below, lists the technological entering capabilities of our users and healing prerequisites for continuing with therapy; our topic and procedural analyses (Appendix A) provide more detail on the use of the game itself.

Entering Capabilities

1. Basic electronics skills (such as the ability to turn on a TV, PC, and/or XBox 360 console)

2. Basic ability to understand electronic hardware (in order to follow instructions to plug the Kinect in and adjust it as necessary)
3. Ability to enter game disc into PC or XBox360 optical drive
4. Ability to load game
5. Ability to navigate through game screens
6. Intermediate understanding of the English language
7. Ability to read and follow instructions on a computer or television screen from 5-8 feet away

Prerequisite Analysis

1) What does the learner need to do before getting started?
   a) Gentle early range of motion exercises
   b) Ice/bracing as needed
   c) Isometric strengthening
   d) Elastic band resisted exercises
   e) Early stretching of calf muscle
2) When is the learner ready to start Level 1-3?
   a) They need physician approval
   b) No pain in their ankle while at rest
   c) Able to walk without alteration or compensation in their gait
   d) Near symmetrical range of motion in both ankles
   e) full weight bearing to injured ankle without use of an assistive device
3) When is the learner ready to advance to level 4-8?
   a) Learner can advance when their ankle has stopped swelling
4) When is the learner ready to advance to level 9-12?
   a) The learner can advance when they can stand on their ankle without pain
5) Progressive Return to Functional Stage
   a) If not limited by pain while walking, progress to short jogging in a line
   b) If this can be done without pain, then increase duration and frequency of jogging
   c) If slow straight jogging is without pain, move to quicker motion and cutting
   d) Try side shuffling, backward jogging, figure eights and Carioca
   e) All of these motions being done pain free indicates a return to normal activity

Section 2: Evidence of Acceptable Results

2-A Formative Evaluation

The formative evaluation of the ankle rehabilitation video game should focus on the quality of the user interface, the ability of the system to instruct users in correct positioning and movement during exercises, and users' perceptions of the effectiveness and ease of use of the system. The formative evaluation will be an ongoing process throughout the design and development of the video game.

Key Questions

1. Is the design/look and color scheme of the game appealing to learners?
2. Does the game encourage and motivate learners to complete the rehabilitation exercises?
3. Are the instructions clear and useful? Are learners able to begin using the game in a timely manner?
4. How long do learners spend engaged in the exercises?
5. Are the exercise positions and movements accurately depicted?
6. Does the feedback provided by the game help users appropriately modify their approach to the exercise?

Approaches to gain information

Approach 1: Learner survey

The learner survey will be used at two points in the design process: after the initial mockup prototype is created and later after the working prototype is created. In both instances, learners will be asked to explore the video game for about 10 minutes and then complete a brief survey about their experience. The survey questions will focus on the learner's response to the video game, including the visual appeal of the game design, and whether or not they think the game would motivate them to complete the exercises.

Approach 2: Usability testing

As the design and development approaches completion and there is a working prototype, approximately 5-8 learners will be observed and recorded as they use the video game. The learners will be given specific tasks to complete as they explore the video game and will be timed as they complete the tasks. Learners will be asked to comment on their experience as they progress through the tasks, specifically focusing on the learner's feelings (frustration/enjoyment, understanding/confusion) as they complete the tasks.

Approach 3: Expert Review

Experts would be involved throughout the process of design, but a formal expert review would be completed when the working prototype was created. The expert would watch the recorded usability tests and evaluate the depictions of the exercises, the feedback provided to the

learner, and the success of the learner in achieving the correct positions and movements required for the exercise.

2-B Summative Evaluation

A summative evaluation will be conducted to determine the extent to which participants have met the learning and performance goals for rehabilitation and assess the short-term and long-term impact of the Kinect game.

Key Questions:

1. How valuable did participants find the coaching and feedback provided in the game?
2. After one week, could participants accurately perform all recommended exercises?
3. How many participants completed all sections of the rehabilitation game recommended by their doctor?
4. How valuable a role did the the game play in participants' ankle rehabilitation?
5. What was the time frame for full ankle recovery for patients using the game?
6. How much time did participants spend using (and learning to use) the game?

Approaches to gain information

Approach 1: Participant Test/Survey (conducted via Xbox)

The game will include the option for participants "Send Scores" or individual exercises to their doctor at any time. Their doctor is connected via Kinect and can view their progress. After the first week, the XBox 360 or PC will prompt users to send a detailed score report generated by the game. The users will be able to view this report and make last minute "changes" by reviewing exercises that day if they wish. Then they can send the report for their doctor to view and follow up on. After selecting "Send Score Report" and receiving the message "Scores Sent Successfully", users will be prompted to answer one multiple choice question on-screen to help improve the game experience. The answers to this mini survey will be sent to their doctor and can be viewed as anonymous responses by the researchers involved in design and development.

When users complete all recommended training, they will be prompted to send a second detailed score report and answer a second survey of just two questions. (In the doctor interview we will confirm the accuracy of XBox assessments of recovery status.) The survey will include one multiple choice and one short answer question.

Approach 2: Interview with Doctors

What feedback have doctors received who offered the Kinect option for ankle rehabilitation? Dr. Gray and other doctors who recommend the ankle rehabilitation program can follow up with their patients and attest to the long-term impact of the program. We will not have access to telephone numbers or the ability to establish direct contact with patients, but they do. Without giving patient-specific information, Dr. Gray can attest to how many patients heal fully, at what pace, and how many continue to sustain injuries. He can help us compare this data to results for patients who do not use this technology. Dr. Gray and any other participating doctors will be interviewed after participants return the Kinect equipment to the clinic during a follow-up visit.

Section 3: Learning Experiences and Instruction

3-A Learner Analysis

Orienting Context	Data Collection for Information
• Do potential users feel that they need this training? • What factors are motivating the learner to attempt/complete rehabilitation? • How should the game be formatted in order to be most accessible for the learners? • What is the gender and age range of learners? • What is the learners' economic background? • What education level do the learners have? • What medical terminology will learners need to understand? • Is this training for learners who just experienced ankle trauma for the first time, or for learners who have recurring rehabilitation needs? • What level are the learners? (Have they received previous rehabilitation?)	Surveys/interviews with potential learners to determine learners' backgrounds and needs for rehabilitation, as well as what information is needed and how it is to be presented in the game (medical terminology vs layman's terms).

Instructional Context	Data Collection for Information
• What is the comfort level of most patients with video game systems, and in particular, the Kinect? • Are learners able to read/communicate in the language that the training is presented in? • What are the goals of the learners? • What role do participants feel they should play in rehabilitation? • What type of accountability is necessary	Surveys and interviews with potential users about their goals, learning styles, objectives, roles, and potential barriers (IE: language).

to ensure that learning objectives are met? • What is the learner's preferred style of learning?	

Transfer Context	Data Collection for Information
• Do learners have access to resources at home that they might need to follow through on the training? • Do learners perceive that the training will improve their quality of life? • Are learners using the skills they learned at other times? • What support is available to learners who are completing or who have completed the rehabilitation?	Survey potential learners about any factors in the home environment that may make it difficult for them to follow through on the training, to determine if they expect the training to improve their quality of life, and if they are using the skills in other situations. Contacting training participants by telephone sometime after the training would be an effective way to receive updated information on their situations and identify needs for further resources, as well as on how useful the training was for them.

Assumptions

Our learners have an ankle injury that is at a stage where the doctor recommends rehabilitation exercises. We are assuming that our learners do not have any other disabilities that would prevent them from participating in ankle rehabilitation or a video game. We assume that our learners are able to follow written and verbal directions in English. We assume that our learners already have access to a television or computer monitor that can be connected to the Xbox Kinect equipment.

3-B Contextual Analysis

Orienting Context	Data Collection for Information
Immediate Environment Factors	
Equipment • Do learners have access to an XBox 360 console or PC for use with the Kinect? **Social Support** • Do learners have prior experience with XBox 360 or another video game console? • Do learners have relatives or friends who have used Xbox 360 or Kinect? • How can the game help onlookers such as family and friends understand and support the rehabilitation process? **Time Factors** • How much time can learners set aside for setting up and learning to use the Kinect system?	**Survey Questionnaire** We will ask participating doctors and therapists to hand out a voluntary survey to potential users, including questions regarding access to compatible technology.
Organizational Factors	
Resources • What funding will this program receive? • Can the clinic purchase Kinect devices and loan them out for patient use? • Can we offer any incentive for doctors and patients to use this rehabilitation program, such as a discount on Kinects (for patients, or for the clinic)? **Learning Culture** • Among learners, are there shared beliefs regarding ankle injury that need to be taken into account?	**Brainstorming Session with Dr. Gray and clinic administrators** These questions can best be answered during a group brainstorming session involving the doctor organizing this program and the individuals capable of allocating funding.
Instructional Context	**Data Collection for Information**
Immediate Environment Factors	
Sensory Conditions • Where in the home will learners set up the Kinect? Is sufficient space available? • What interruptions and distractions could interfere with learning?	**Survey Questionnaire** The survey of potential users will include questions related to the room, number and age of family members, and time constraints.

Instructor Role Perception • What role does the virtual trainer play in the transfer and acquisition of knowledge? How will this differ from the role of the actual doctor? **Learning Schedules** • How regularly are learners able to use the Kinect program? How will the programmed schedule adjust based on individual learner needs? • Within the rehabilitation game, how much time should be devoted to motor skills (learning new exercises, performing learned exercises, achieving greater accuracy) and how much to knowledge skills (understanding what the exercises do, why they are beneficial, and how to prevent injury)? • What factors will influence when learners can advance to the next exercise or level? **Content culture** • What tone and diction will be used by the virtual coach during explanation, advice, encouragement, warning, correction of learner mistakes, and congratulation of learner achievements?	**Interview with Dr. Gray** Dr. Gray can answer questions about ideal division of time and emphasis within the game, as well as scaffolding and learner and instructor roles.
Organizational Factors	
Rewards and Values • How will participation be encouraged and rewarded? **Learning Supports** • What videos, FAQs, posters, pamphlets, or other resources would provide the best technical support? • What calendars, planners, posters, checklists or apps could remind learners of	**Brainstorming Session with Dr. Gray and clinic administrators** During the brainstorming session conducted regarding funding, we will ask about additional resources and reminders that the clinic may already provide or have access to. We will schedule simulations and a deadline for review.

the rehabilitation schedule and keep them on track? **Teaching Supports** • In order to create the virtual coach, can simulations be conducted in which an actor (stand-in for real patient) tests the prototype and experts such as Dr. Gray give feedback and advice? • Can Dr. Gray review the script for the virtua coach and make changes and additions to ensure accuracy?	
Transfer Context	**Data Collection for Information**
Immediate Environment Factors	
Transfer opportunities • Where is a form of continuing prevention-focused support available to learners, such as an e-newsletter showing stretches to prevent injury? **Social support** 1. How can the game influence onlookers such as family and friends to support the learner in healthy practices such as stretching before exercise in the future? I. How can the game influence onlookers such as family and friends to also take preventative measures to avoid injury? **Situational cues** I. What cues in daily life will remind learners of useful exercises and information presented in the game?	**Telephone Interview** Contacting participants by telephone sometime after the rehabilitation would be an effective way to receive updated information on their situations and identify needs for further resources, as well as how family and friends perceived the game and rehabilitation process
Organizational Factors	
Transfer Culture: I. Does the clinic have a website learners	**Brainstorming Session with Dr. Gray and clinic administrators**

could use to review tips and stretches online even after completing rehabilitation? **Incentives:** Preventing future injuries is the primary incentive for carrying over what has been learned in the rehabilitation game. Are other incentives or reminders needed? Could the game prompt learners to create these reminders or incentives for themselves before returning the rehabilitation game and any borrowed equipment to the clinic?	During the brainstorming session, we can discuss the possibility of additional incentives and find out what continuing support the clinic offers.

Assumptions

For sections III-C Types of Learning Experiences and Instruction and III-D Materials for Training, we will assume that learners have access to a XBox 360 console or PC for use with the Kinect. We will assume that the clinic has sufficient funding to purchase Kinects and that the Kinect itself, as well as the rehabilitation game, can be rented out to learners by the clinic. We will assume that sufficient space is available in the home for performing these exercises and that, while there may be distractions, they will not be so great as to interfere with the Kinect sensor or prevent hearing in-game audio, including spoken instructions.

3-C. Types of Learning Experiences and/or Instruction

The learning experiences in this video game are mostly comprised of the user following prompts on-screen, mimicking the actions of a "model," or as in our example interface mockup, performing actions that they are familiar with such as moving their ankle as if they were driving a car. Learners are encouraged to view the lesson's instructions as well as the demonstration before practicing motions that might be painful or dangerous if performed incorrectly. In the event that the learner is unable to perform the motion correctly, the Kinect will provide instant feedback and allow them to correct their movements; they also have the option of watching the demonstration again, if needed.

Behavior Objectives for Learner	Type of Learning: Content / Performance	Instructional Strategy	Rationale
1.1 After completing the video game, patients will	Procedure / Recall	Elaborative Interrogation	Patient should be able to answer questions or prompts about the

be able to recall the rehabilitation process with 90% accuracy.			process given by the video game to test knowledge of entire process
1.2 After completing each exercise, patients will be able to state their current limitations (e.g. can't run on it, or needs to be elevated at night)	Concept / Recall	Elaborative Interrogation	Patient should be able to answer questions or prompts about their limitations given by the medical professional
2.1 After reading the step-by-step instructions provided with the game, the patient will be able to set up the Kinect sensor with their Windows PC or XBox 360 console without encountering any error messages.	Procedure / Application	Demonstration of still pictures/text instructions followed by troubleshooting	Patients will be able to view the process in the step-by-step directions before attempting it themselves. The instructions will also include a "troubleshooting" question with common issues and links to further resources on the Kinect website.
2.2 After seeing a demonstration on their television and practicing each rehabilitation exercise with coached feedback, the patient will be able to perform the correct body position and muscular movements in front of the Kinect with 90% accuracy.	Procedure / Application	Demonstration on-screen followed by practice with feedback and troubleshooting	The game will show patients the exact exercises they need to perform, often with real-world metaphor ("driving a car.") The Kinect sensor then "observes" the patient performing the exercise, and the game offers feedback.
2.3 After using the rehabilitation game for a period of one week, the patient will be able to perform the correct body position and muscular movements in front of their doctor or physical therapist with 90% accuracy.	Procedure / Application	Demonstration, practice, feedback and troubleshooting	While the video game will offer feedback based on the Kinect sensor, this cannot entirely replace the advanced knowledge of a medical professional; the patient's doctor or therapist will also watch them practice the motions and offer feedback after they have had a chance to practice with the Kinect
3.1 Given a series of exercises, the patient will	Procedure / Application	Demonstration and practice	The game will prompt the user to perform the exercise the number

perform each for the recommended number of repetitions with 90% accuracy.			of times recommended for optimal therapy so that the user does not have to remember or keep track
3.2 After completing each exercise, patients will be able to state the purpose of each exercise with 100% accuracy.	Principle / Recall	Elaborative Interrogation	The patient will be able to respond to the questions or prompts of their doctor or therapist about the purpose of each exercise in order to promote maximum understanding and, thus, increased motivation
3.3 Given a weekly schedule of exercises that updates based on progress toward full rehabilitation, the patient will complete recommended exercises at least 4 days out of the week to meet rehabilitation goals.	Procedure / Application	Demonstration and practice	The video game will provide the user with a module in order to show users the recommended number of therapy days per week, and then the user must practice consistently performing these procedures

3-D Materials for Training

Storyboard

The story for this game serves two purposes. First, it provides context to frame each exercise. This helps the player cognitively understand what they are expected to do at each stage. Second, the context processing necessary to play the game correctly can distract players from the monotony of performing the same exercises repeatedly day after day. In order to have a game scenario that is repeatable yet still fun; the excitement shouldn't come from discovery (ie: story progression), but rather from better performance, such as setting a high score.

The fourth exercise is "Ankle Range of Motion", which we have chosen as an example to design. The exercise requires patients to "without moving their leg, move their ankle up and down, pushing their toes hard towards their nose, than away from their head; in towards their other foot, then away from it." This motion fits very naturally with the motions needed to accelerate and brake in a car. The patient is required to navigate around the track trying to set their "Best Time". The player will have a virtual driving coach who will encourage them when to brake or gas, and will correct any incorrect motions the player does. After the player finishes 3 laps they will receive their individual lap times as well as their total race time, and then be shown comparisons between these scores and their past scores.

1) In order to accelerate players must turn their ankle toward the right and point their toes down.
2) In order to brake players must turn their ankle towards the left and point their toes down.
3) In order to stop accelerating or braking players must point their toes up.
4) In order to get the best time possible, players will have to push the gas hard on straightaways, and then brake around turns.

3-E Implementation Plan

Data and feedback will be gathered from professionals and possible participants in the study to help shape the creation of the video game. Throughout the study the instructional design team will collaborate with the subject matter experts to make sure the game is using correct rehabilitation exercises.

Potential participants will be identified by doctors and other clinicians working with individuals who have experienced ankle trauma. The potential participants will be given a survey to verify that they are a good fit for the study, as well as to seek information regarding their goals, expectations, and concerns regarding rehabilitation.

Participants who are selected to participate in the study will be loaned Xbox360 and Kinect components. While instructions for connecting the equipment to the patient's existing television or computer will be provided and some troubleshooting will be provided as requested by phone or email, no technicians will be available to travel to participants' homes to assist with installation. The loaned equipment will be available to the participant for the entire duration of the rehabilitation period, as specified by the doctor.

Participants will proceed through the video game learning exercises at their own pace, although they may receive feedback about their timing as they complete the exercises. Exercises will be sequenced according to difficulty. As they proceed through the video game, learners will be able to proceed to the next exercise based on time and performance.

After completing rehabilitation, learners will be contacted for a telephone interview regarding their experience.

Schedule

May-June 2013	Development of prototype; interviews and brainstorming with subject matter experts and administrators.
July-September 2013	Participants are selected and rehabilitation begins; length of time in rehabilitation varies according to doctor recommendation. Follow-up telephone interviews are conducted approximately four weeks after successful completion of rehabilitation.
November 2013	All follow-up telephone interviews are completed by the end of this month.

Appendixes

Appendix A. Needs Assessment Instruments and Evaluation Materials

A.1 Needs Assessment Instruments

Interview with Dr. Gray

1. What ankle exercises should participants perform? How are these exercises scaffolded or divided into levels of what the patient is ready for?

2. How often and for how many repetitions should each exercise be performed? How much time per day do patients need to set aside for performing rehabilitation exercises? How many days per week should patients perform some kind of ankle exercise?

3. Where should exercises be performed? (at home, in the doctor's office, etc)

4. How well do participants understand and perform ankle exercises?

5. How long does the full rehabilitation process take? Does repeating exercises more often shorten the time it takes for full rehabilitation? What are the risks of performing an exercise too often or not enough?

6. Can your clinic provide patients with a Kinect during rehabilitation? Could a Kinect and--if the user does not have a Windows PC--an XBox 360 console be loaned or rented to patients who do not have access to one at home? Does the clinic need additional funding for this purpose, or could it be covered by a patient's insurance?

7. What are the primary reasons for not keeping up with exercises as scheduled?

8. What are the primary reasons for carrying out an exercise incorrectly?

Voluntary Survey

1. During your ankle rehabilitation, how many days per week have you performed recommended exercises?

a. One day per week or less
b. Two or three days per week
c. Four or five days per week
d. Six or seven days per week

2. On days that you performed rehabilitation exercises, how much time have you typically spent on exercises?

a. Under 5 minutes per day
b. 5 to 10 minutes per day
c. 10 to 15 minutes per day
d. 15 to 20 minutes per day
e. More than 20 minutes per day

3. At home, which of the following do you have access to? (Select all that apply

__ TV
__ XBox
__ XBox Kinect
__ Windows PC with Internet

4. Select the statement that best describes how you feel about the recommended ankle rehabilitation exercises.

a. They're very important at the beginning, before you're back on your feet.
b. They're very important both before and after resuming daily activity.
c. They're important in theory, but in actual practice they don't seem worth the time.
d. They're really not necessary as long as you're careful not to re-injure the ankle.

5. How interesting do you find the recommended exercises?

a. Very tedious or boring.
b. Somewhat tedious or boring.
c. Neither boring nor interesting.
d. Somewhat fun or interesting.
e. Very fun or interesting.

6. How difficult do you find using new technology such as an Xbox Kinect game?

a. Very easy
b. Somewhat easy
c. Somewhat difficult
d. Very difficult

7. How interesting do you find new technology such as Xbox Kinect games?
    a. Very interesting
    b. Somewhat interesting
    c. Somewhat uninteresting
    d. Not interesting at all

8. Have you had any trouble keeping up with exercises as scheduled? If so, what are the primary reasons?

9. Have you had any trouble performing exercises correctly? If so, what are the primary reasons?

A.2 Task Analysis

Topic Analysis

1) What is Kinect?
    a) Peripheral accessory for XBox 360 video game console
    b) Used to track motion of one or more users
    c) SDK and developer toolkit can be used to create custom games and applications
    d) Face recognition
    e) Speech recognition
    f) Can be used as hands-free media remote

2) Setting up Kinect

a) Can be used with XBox 360 console or PC
    i) Must have power-supply unit and USB cable to connect to either
b) Use with PC
    i) Must install SDK and developer toolkit (see resources)
    ii) No additional tools required for calibration of audio and video
    iii) How to change settings
c) Use with XBox 360
    i) Console software loaded automatically with XBox Live
        (1) Internet connection required
    ii) Automatically sign player into XBox Live profile
    iii) How to change settings

3) Uses for Kinect
    a) Single-player
    b) Multiplayer
    c) Play recreational games
    d) Physical exercise/fitness
    e) Perform physical therapy exercises for ankle injury
        i) Should only be used if seeking treatment from licensed medical doctor or physical therapist
        ii) Ankle rehabilitation game
            (1) Severity of injury
            (2) Full scope of healing process

4) What is an Ankle Sprain
    a) Stretch or tear in ankle joint ligaments
    b) 3 grades of severity
        i) Pain with minimal ligament damage
        ii) More damage and mild looseness of joint
        iii) Complete ligament tearing, and joint is unstable
    c) How long does full recovery take
        i) Few weeks - a few months
        ii) Depends on condition (health/age) of patient and severity of sprain
    d) How does it occur
        i) A sprain is usually caused by twisting the foot
    e) How is it diagnosed
        i) Health care provider reviews symptoms
        ii) X-rays may be taken to be completely sure
    f) How is it treated
        i) Applying ice packs
        ii) Elevating the ankle
        iii) Wrapping an elastic band
        iv) Wear a leg or ankle brace
        v) Taking anti-inflamatory medicines

vi) Doing ankle rehabilitation
vii) Very Rare and Serious sprains require surgery

g) How it can be prevented
i) Wearing proper well-fitted shoes
ii) Stretching before and after athletic activity
iii) Avoiding sharp turns or quick changes in direction while moving
iv) Taping or bracing the ankle particularly if you are prone to the injury

5) What are the Ankle Rehab Exercises
a) Towel stretch
i) Sit on the floor with leg stretched in front
ii) Loop a towel around the ball of your foot and pull
iii) Keep your knee straight for 15-30 seconds
iv) Repeat 3 times

b) Standing calf stretch
i) Facing a wall put your hands on the wall at eye level
ii) Place one foot a few feet behind the other
iii) Turn your back foot slightly inward
iv) Slowly lean into the wall for 15-30 seconds
v) Repeat three times for a set
vi) Perform several sets throughout the day

c) Standing soleus stretch
i) Standing facing a wall with your hands on a wall at chest level
ii) With both knees slightly bent and one foot back
iii) Angle the toes of your back foot inward
iv) Gently lean into the wall for 15-30 seconds
v) Repeat three times

d) Ankle range of motion
i) Sitting or lying down with your legs straight
ii) Move your ankle up and down by pointing your toes to your nose then away from your body and in and out from your other foot
iii) Only move your foot and ankle (don't move your leg)
iv) Repeat 10 times in all directions

e) Resisted Ankle Dorsiflexion
i) Sit with one leg out straight and your foot facing a doorway
ii) Tie a loop in one end of elastic tubing
iii) Put your foot through the loop so its looped around the arch of your foot
iv) Tie a knot in the other end of the tubing and shut the knot in the door
v) Move backward until there is tension in the tubing
vi) Pull your foot toward your body
vii) Slowly return to starting position
viii) Do 3 sets of 10

f) Resisted Ankle Plantar Flexion
i) Sit with your leg outstretched and loop the middle section of the tubing around the ball of your foot

ii) Hold the ends of the tubing in both hands
iii) Gently press the ball of your foot down and point your toes
iv) Slowly return to the starting position
v) Do 3 sets of ten

g) Resisted Ankle Inversion
i) Sit with your legs out straight and cross one leg over your ankle
ii) Wrap elastic tubing around the ball of your bottom foot and then loop it around your top foot so that the tubing is anchored
iii) Hold the other end of the tubing in your hand
iv) Turn your bottom foot inward and upward
v) Slowly return to the starting position
vi) Do 3 sets of ten

h) Resisted Ankle Eversion
i) Sit with both legs stretched out in front of you with your feet about a shoulder's length apart
ii) Tie a loop in one end of elastic tubing
iii) Put one foot through the loop so that the tubing goes around the arch of that foot and wraps around the outside of the other foot
iv) Hold onto the other end of the tubing with your hand providing tension
v) Turn the foot with the tubing up and out
vi) Make sure you keep your other foot still so that it will allow the tubing to stretch as you move your foot with the tubing
vii) Slowly return to the starting position
viii) Do 3 sets of 10

i) Heel Raise
i) Balance yourself while standing behind a chair or counter
ii) Raise your body up onto your toes and hold for 5 seconds
iii) Then slowly lower yourself down
iv) You can hold the chair or counter if you need to
v) When this exercise becomes less painful try lowering on one leg
vi) Repeat ten times for a set
vii) Do 3 sets of ten

j) Step-Up
i) Stand with the foot of one leg on a support 3-5 inches high
ii) Keep your other foot flat on the floor
iii) Shift your weight onto the leg on the support and straighten the knee as the other leg comes off the floor
iv) Lower your leg back to the floor slowly
v) Do 3 sets of 10

k) Balance and Reach Exercises
i) Stand upright to a chair
ii) This will provide you with balance if needed
iii) Stand on the foot farthest from the chair
iv) Try to raise the arch of your foot while keeping your toes on the floor
v) First,

(1) Keep your foot in this position and reach forward in front of you with your hand farthest away from the chair allowing your knee to bend
(2) Repeat 10 times while maintaining the arch height
(3) This exercise can be made more difficult by reaching farther in front of you
(4) Do 2 sets

vi) Second,
(1) Stand in the same position as above
(2) While maintaining your arch height reach your hand farthest away from the chair across your body toward the chair
(3) The farther you reach the more challenging the exercise
(4) Do 2 sets of 10

l) Jump Rope
i) Jump rope landing on both legs for 5 minutes
ii) Jump rope landing on only one leg for 5 minutes

Procedural Analysis

1.0 Procure Kinect and either an XBox 360 or Windows PC
2.0 Connect Kinect to PC or XBox 360
2.1 Use with PC
2.1.1 Mount on a flat, stable surface
2.1.2 Make sure the Kinect can "see" your entire body
2.1.3 Must install SDK and developer toolkit (see resources)
2.1.4 Plug in power supply and USB
2.1.4.a You should see all drivers load automatically
2.1.4.b No additional tools required for calibration of audio and video
2.2 Use with XBox 360
2.2.1 Place the sensor on a flat, stable surface
2.2.2 Make sure the Kinect can "see" your entire body
2.2.3 Connect the cable to the XBox 360 and the power supply outlet
2.2.4 Update your console software by signing into XBox Live
2.2.5 Signing in with Kinect
2.2.5.a Sensor can detect face and choose correct XBox Live profile
2.2.5.b Needs a clear, well-lit view of face
3.0 Load Game
3.1 Put game disc in disc drive
3.1.1 For PC, may need to load directly from hard drive
3.2 Sign In
3.2.1 Create new account
3.2.1.a Enter name
3.2.1.b Select gender
3.2.2 Sign in to existing account
3.2.1.a Select name from list of users
3.3 Perform exercises

3.3.1 Select exercise from list of available modules
3.3.2 Watch video of model performing exercise
3.2.4.a Repeat video, if necessary
3.3.3 Perform exercise that model demonstrated
3.2.5.a Repeat exercise, if necessary
3.3.4 Select another exercise from list

3.4 Save/Exit game
3.4.1 Select Kinect "settings" menu
3.4.2 Choose "Save and quit"
3.4.3 Turn off console or PC

A.3 Formative Evaluation Instruments

Survey for Learners

Explore the video game for about 10 minutes and then answer the following questions.

1. Based on your first impressions of the video game, would you be interested in participating in a rehabilitation program using a video game? Why or why not?

_____
_____

2. How comfortable were you navigating through the video game? Were you confused or surprised by how it worked? Please explain.

_____
_____

3. Would using a video game during rehabilitation motivate you to complete your exercises? Why or why not.

_____
_____

4. Is the video game visually appealing?

_____
_____

5. Are there visual elements that are distracting?

_____
_____

6. What other comments/questions/suggestions do you have regarding the video game?

_____
_____

Usability Testing Guide

Participant Profile
Age / Gender:
Has previous Kinect experience:
Has previous rehabilitation experience:

Testing Conditions

Date of Test	

Observation

Task 1

Description	Within the video game, make one circuit around the track.
Time to complete	
Errors/problems encountered	
User comments	

Task 2

Description	Intentionally disobey the coach's instructions to receive corrective feedback from the coach.
Time to complete	
Errors/problems	

encountered	
User comments	

Task 3

Description	Correct your positioning based on the feedback you receive from the video game.
Time to complete	
Errors/problems encountered	
User comments	

Subject Matter Expert Review

Watch the recorded usability testing and then rate the items below using the following scale:

5 = Excellent 4 = Very Good 3 = Good 2 = Acceptable 1= Minimal 0 =Unacceptable

Item	**Rating**
Directions for completing the exercise	
Feedback provided to learner	
Success of learner in achieving correct positioning	
Consistency of content	
Distractions are minimized	

Additional comments (suggestions: strengths, weaknesses, tips):

A.4 Summative Evaluation Instruments

Participant Test/Survey #1 (End of Week 1)

Sections in Bold have been recommended by your doctor--sections that don't apply to you have been grayed out on this report.

Sections	Average Accuracy (0-100%)	Most Recent Accuracy (0-100%)	Days Completed (M-T-W-H-F)	Total Reps
Introduction				
Exercise #1				
Exercise #2				
L1 Challenge				
Exercise #3				
Exercise #4				
Exercise #5				

A quick question to improve our game...

1. How helpful was the coaching and feedback provided in this game?
    a. Very helpful--I understood exercises fully and could get them right.
    b. Somewhat helpful--They were good but sometimes left me with questions.
    c. Somewhat unhelpful--The explanations were confusing or unclear.
    d. Very unhelpful--I was often frustrated because I couldn't tell what I was doing wrong!

Participant Test/Survey #2 (End of Program)

Sections in Bold have been recommended by your doctor--sections that don't apply to you have been grayed out on this report.

Sections	Average Accuracy (0-100%)	Most Recent Accuracy (0-100%)	Days Completed (M-T-W-H-F)	Total Reps
Introduction				
Exercise #1				
Exercise #2				
L1 Challenge				
Exercise #3				
Exercise #4				
Exercise #5				
L2 Challenge				
Exercise #6				
Exercise #7				
Exercise #8				
L3 Challenge				
Exercise #9				
Exercise #10				
L4 Challenge				
Exercise #11				

Exercise #12				

1. How valuable a role did the the game play in your ankle rehabilitation?

a. Very major--The game kept me motivated and contained all the exercises and information I needed.

b. Somewhat major--The game helped me perfect the exercises and stay on track but I used other resources too.

c. Somewhat minor--I used the game only as an occasional resource.

d. Very minor--I did not find the game useful.

2. How much time did you spend using (and learning to use) the game? Was taking the time to become familiar with the Kinect worthwhile for you?

Interview with Dr. Gray

1. How valuable did participants find the coaching and feedback provided in the game?

2. After one week, could participants accurately perform all recommended exercises?

3. How many participants completed all sections of the rehabilitation game that you recommended?

4. How valuable a role did the the game play in participants' ankle rehabilitation?

5. What was the time frame for full ankle recovery for patients using the Xbox Kinect game?

6. How much time did participants spend using (and learning to use) the game? Was this a worthwhile use of their time?

Storyboard: Scene 1

The player selects Exercise 4: Ankle Range of Motion for the first time. The exercise begins.

Coach: Hello, my name is Julia and I'll be your driving coach today. Before we start, I need to tell you about a couple safety precautions. First of all, when driving, I need you to move just your ankle, not the rest of your leg. I don't want us swerving all over the road! Second, please start off slow. I can't have you driving sixty miles per hour on the beginner's course. We'll work up to that, ok? Now, if you're ready to begin your first driving lesson, position your foot in the middle of the set of red arrows.

Storyboard: Scene 2

The player has position his foot correctly. The driving lesson continues.

Coach Julia: Great! Now, let me show you where the pedals are for braking and acceleration.

[Flashing white arrows appear]

Coach Julia: To accelerate, you will need to point your toe to the right and down. To brake, point your toe to the left and down. In between accelerating and braking, point your toe up as high as you can comfortably, bringing the heel down. Simple enough, right?

[Depending on which ankle is injured, the player may be driving with his left foot. This is ok! When starting the game for the first time, the player selects which ankle is in need of recovery so that all exercises will monitor the correct motion.]

Storyboard: Scene 3

Coach Julia: Let's give it a try. Point your toes upwards and straight ahead. [Player's toes are too low]

Coach Julia: A little higher. [Player adjusts]

Coach Julia: Great. Now accelerate, moving them to the right and down, while keeping the rest of your leg in place. [Player does as directed and the indicator on the "speedometer" moves into the yellow range]

Coach Julia: That's pretty good. We're moving! Take a look at your speedometer. As your range of motion improves you will be able to achieve higher speeds and also more accurate breaks. This doesn't mean you have to move your ankle faster! The only thing that will increase your speed is gradually improving your flexibility as you heal.

Storyboard: Scene 4

The player has made it halfway around the track.

Coach Julia: Ok, watch the track ahead. You're going to need to break a lot coming around this turn. It doesn't have to be fast. The best brakes are smooth and easy. But do get those toes down as far as you can. [Player brakes correctly by raising toes and then pointing them to the left and down. Player continues around the track to finish the first lap.]

Coach Julia: First lap complete! Just two more to finish the race and view your scores! Don't worry, it's not really a race yet—you don't have anyone to compete against. But next time you come back, you will. Believe it or not you'll be competing against... yourself! This little blue car you're driving now will head around the track just as before, you'll be driving a car that's brand spanking new, and you can wave at yourself as you drive by! [Julia winks. The player completes two more laps for a score summary for this exercise]

Storyboard: Scene 5