**Name of Activity**: Flipped classroom model for introduction and case based application to lower extremity orthotics

*Innovation; Intervention*

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**Course Information:**

Neuromuscular Physical Therapy I; 4 credits; This class activity is integrated in a neuromuscular course as an introduction to concepts for lower extremity orthotics prescription. This activity is delivered prior to the introduction of diagnostic specific neurologic content in order to allow concepts of orthotics prescription to be reinforced across diagnosis and across the lifespan.

**Learning Experience Description:**

Context: This learning activity is based on a flipped classroom approach where the students are expected to complete an assigned reading OR a prerecorded lecture introducing principles of different orthotics, complete a study guide and view short videos that provide a visual introduction to lower extremity orthotics prior to coming to class (see files entitled *Video LE Orthotics 1 – 7*). The instructor can opt to give a quiz at the start of class in order to make the students accountable for the work. Class time is then spent problem solving and discussing patient cases that allow the students to compare and contrast the different orthotics and factors contributing to orthotic prescription.

Purpose: The purpose of this flipped classroom approach is to expose the students to basic concepts of orthotics prescription prior to coming to class in order to allow students to focus on clinical reasoning and application of orthotics principles during class time.

Student Instructions**:**  
Preparation Assignment for Orthotics Class (Provided to the students to set expectations):  
This class session is utilizing a flipped classroom approach where students are provided basic concepts prior to class in order to allow class time to focus on case based application of the material.  The hope is that students will do most of the studying prior to coming to class so that class time can be utilized to apply and clarify concepts.  **Therefore, students are expected to complete the following task PRIOR to coming to class on {insert date here}.**   **This is the information you will be quizzed on at the start of class.**  
  
1. View the pre-recorded lecture labeled:  Prep Assignment for Orthotics Class.  OR Complete the assigned readings: Edelstein JE, Wong CK. Orthotics. In: O’Sullivan SB, Schmitz TJ, Fulk GD. Physical Rehabilitation. 6th ed. 2014. F.A. Davis Company, Philadelphia, PA. 1325-1360   
2. Study Guide for Prep Assignment: You may find it useful to take notes about the different types of orthotics while viewing the recorded lecture or completing the readings. You can use this document to guide your learning  
  
3.  Short videos highlighting different components of lower extremity orthotics are posted on the course website.  These are meant to supplement the prerecorded information and/or reading assignments.

Sample Study Guide Provided to Guide Learning (Provided to the students to supplement the required reading or prerecorded lecture):

1. Describe 3 purposes of an orthotic.

2. For each of the following types of orthotics, list the benefits and contraindications for their use.

a. Foot orthosis

b. Supra Malleolar Orthosis (SMO)

c. Posterior Spring Leaf

d. Carbon Fiber AFO

e. Solid AFO

f. Articulating AFO (include specific features)

g. Dynamic Ankle Foot Orthosis (DAFO)

h. Knee Ankle Foot Orthosis (KAFO)

i. Hip Knee Ankle Foot Orthosis (HKAFO) and Reciprocating Gait Orthosis (RGO)

3. Describe 3 key factors for deciding which orthosis to recommend and how they help in your

decision making.

4. Describe 3 key points for assessing if an orthotic is appropriately fit to your patient.

5. Describe 3 priorities for patient/family education when they first receive an orthotic.

1. **Description (the actual activity: questions posed, patient case, etc. Please be clear and specific such that a novice educator could replicate the activity):**

**Example Structure of Class Activity:**

Quiz – 5 minutes (Optional to Assess Student Learning over Prep Assignment)

Review Quiz and introduce format of the class – 5-10 min

Case 1: Introduce case and present “Additional Exam Findings”- 5 min

Small Group Discussion with Guided Questions – 10 min

Large Group Discussion with Guided Questions – 10 min

Case 2: Introduce case and present “Additional Exam Findings”- 5 min

Small Group Discussion with Guided Questions – 10 min

Large Group Discussion with Guided Question – 10 min

Case 3: introduce case and present “Additional Exam Findings”- 5 min

Small Group Discussion with Guided Questions – 10 min

Large Group Discussion with Guided Question – 10 min  
 Case 4: Present if groups end up going quickly

In the example class structure above, the students work in small groups of 4-6 students in order to answer the guiding questions and identify their orthotics recommendations for the specific case. Following their decision, each group should report their recommendation such as writing their answer on the board. The instructor then leads a large group discussion comparing and contrasting the selected orthotics until the optimal orthotic is selected.

**Class Hand Out:** This document is provided to the students to guide their learning during class. It contains the patient cases, additional examination findings, and guided questions which can be used to facilitate discussion.The patient cases below are provided for use during this learning activity. However, due to patient confidentiality, patient videos are not able to be shared at this time. In order to add a visual component to the learning activity, the instructor may elect to develop his or her own cases which include patient videos.

**Class activity:** Clinical cases will be used to facilitate small group and large group discussions around orthotics prescription. For each case, an introduction to the case along with additional examination findings will be presented to the class. Students will then work in small groups to discuss specifics of the case and answer the guided questions for small group discussion. The class will then come back together in order to discuss their recommendations for orthotics prescription and answer the guided questions for the large group discussion.

**Guiding Questions for Small Group Discussion:**

1. What are the patient's primary impairments and functional limitations?
2. What factors should you consider when deciding on an appropriate orthotic for this patient and why?
3. What additional questions would you ask the patient/family when considering the most functional brace for the patient?
4. At this point, what type of orthotic would you recommend and why?

**Guiding Questions for Large Group Discussion:**

1. What orthotics were you deciding between and what made you choose one over the other?
2. Would you make any changes to your recommendations based on your clinical reasoning discussed in the large group? What observation or piece of information affected your decision?
3. What patient/family education topics do you anticipate need to be addressed in order to promote success with the orthotic?
4. How will you know if the orthotic is appropriately fitting the patient?

**Patient Cases:**

**Case #1:** RB is a 62 year old male who fell off a ladder while working as a handyman. He presents to inpatient rehabilitation 2 weeks after his accident with a diagnosis of traumatic brain injury and spinal fractures at C2-3 and C5-6. He has orders for use of the sternal-occipital-mandibular immobilizer (SOMI) at all times. He was previously independent with all activities of daily living and was working most days of the week. He is divorced with 1 adult son who is in college. He lives alone in a 2 story home that he was currently having renovated.

Additional Examination Findings:

* Rancho Los Amigos Level of Cognitive Functioning: Level VII
* Moderate assist for stand pivot transfers
* Moderate assist x 2 for gait with reciprocating flexion and extension synergies noted on the left lower extremity during gait. Use of left lower extremity extensor synergy during stance phase of gait with patient requiring only minimal manual facilitation at left quad and gluteal for muscle activation.
* Modified Ashworth Scale of 2 in left quads, plantarflexors and adductors
* Strength 5/5 on the right
* Strength: 1 for left hip flexion, hip extension, quads and hamstrings

0 for left hip abduction

0 at for ankle plantarflexion and dorsiflexion

Left UE grossly 0

* Sitting balance was fair
* Static standing balance was poor with contraversive pushing noted as patient falling towards the involved left side
* Sensation impaired to light touch and proprioception

**Case #2:** KL is a 5 year old boy with delayed achievement of motor milestones related to static encephalopathy. He has been receiving outpatient services since he was 3 years old, participating in both land and aquatic based services since he was 4 years old. KL has been assessed with the PDMS-2 in the past, consistently scoring in the 1st percentile for total gross motor skills. KL is now in kindergarten and receives educationally-based therapy services. He demonstrates a global delay, receiving outpatient speech therapy services (uses a Dynavox communication device and some sign language) and outpatient occupational therapy services for sensory, vision, and fine motor impairments. Intervention is addressing strength, balance, coordination, and motor planning to be able to perform age-appropriate skills such as running, jumping, walk up/down the steps with 1 ft/step pattern, and propulsion/steering tricycle around simple obstacles.

Additional Exam Findings:

* Able to perform squat to stand, stoop and recover, and plantargrade to stand in a slow and segmented manner with stand-by assist, with observed decrease in eccentric quadriceps strength.
* Ascends stairs with right LE lead and descends stairs with left LE lead, with use of bilateral UE support and contact guard assist.
* Unable to perform half kneel to stand, jump with surface clearance, or independently step up onto 4" height curbs.
* Demonstrates fair static standing balance and poor dynamic standing balance.
* Demonstrates decreased postural and gait stability, ambulating in a slow and consistent manner with ability to increase pace for short bouts. Unable to run with float phase. Postural observations during static standing and gait include: shoulder width base of support, over pronation at ankles, knee hyperextension in stance phase, minimal postural sway, and upper extremities in mid guard position.

**Case #3:** HJ is an 8 year old boy who was born at 25 weeks gestation, who presents with triplegia. HJ’s medical history includes hemiplegic cerebral palsy affecting his left upper and lower extremity, infarct paralysis in his right lower extremity due to multiple IV blood transfusions when he was 9 days old, bronchopulmonary dysplasia, seizures, a ventriculoperitoneal shunt, and left hip dislocation with resulting leg length discrepancy. He demonstrates flaccid paralysis in the right LE, and some function on the left. HJ uses a wheelchair for functional mobility and requires a 2 person transfer. Since he was 6 years old HJ ambulated with use of KAFOs and a posterior walker while at school and occasionally at home, and prior to this ambulated with KAFOs and a gait trainer. However, he is now requiring a more energy efficient and functional mode of ambulation as he is now getting older and growing taller.

Additional Exam Findings:

* Solid AFOs for positioning and alignment while in wheelchair and performing functional floor mobility and transfers.
* Decreased functional AROM in left upper extremity due to increased muscle tone.
* Slight contracture in right knee flexion.
* Use of upper extremities (preferably right) to assist with movement of lower extremities.
* Use of trunk momentum to assist with functional movement of lower extremities.
* Cognitively age appropriate.

**Case #4:** SS is a 21 year old female recovering from a left CVA due to brain aneurysm rupture status post coiling. She is getting ready to discharge home from inpatient rehabilitation with contact guard assist for gait and supervision for transfers. Her family will provide 24/7 care in their 2 story home where SS’ room is on the second floor. SS was previously independent with all ADL’s, living independently in an apartment, and attending college.

Additional Exam Findings:

* Gait 200 feet with single point cane and contact guard assist for balance. Noted foot drop on the right resulting in a high stepping gait on the right
* Strength on right: hip grossly 4  
   knee extension 4   
   ankle plantarflexion 1   
   ankle dorsiflexion 0
* Modified Ashworth Scoreon the right = 0 throughout

**Instructor Key to Patient Cases:**

**Case #1**

**Guiding Questions for Small Group Discussion:**

1. What are the patient's primary impairments and functional limitations?

* Primary Impairments: left LE weakness, spasticity, decreased sensation, left lower extremity reciprocating synergies, impaired standing balance
* Functional Limitations: moderate assist for transfers, moderate assist of 2 people for gait.

1. What factors should be considered when choosing an orthotic for this patient and why?

* Significant spasticity that is negatively affecting function will need to be inhibited
* Functional use of an extension synergy for stance phase of gait.
* Muscle weakness on the left requiring assistance to clear the foot during swing.
* Cognition secondary to the diagnosis of TBI – tolerance and learning issues.

1. What additional questions would you ask the patient/family when considering the most functional brace for the patient?

* What type of insurance will be providing coverage?
* Are there any family members who will be able to assist in donning/doffing an orthotic once he discharges?
* Does he have any pain during mobility?

1. At this point, what type of orthotic would you recommend and why?

* A solid ankle foot orthosis with an instep strap was recommended for inhibition of plantarflexion tone, inhibition of knee hyperextension during stance phase of gait, and assistance with limb clearance during swing phase of gait.

**Guiding Questions for Large Group Discussion:**

1. What orthotics did you consider and how did you choose one over the other?

* Based on student responses, compare and contrast orthotics and appropriateness of the recommendation.
* Other possible recommendations:
  + Dynamic ankle foot orthosis would not provide enough proximal stability since this is an adult patient and there is a significant amount of spasticity present.
  + A knee ankle foot orthosis or a hip ankle foot orthosis may be considered due to lower extremity weakness. However, the patient was able to utilize the extension synergy pattern to functionally assist with stance phase. As a result, the need for more proximal support is not necessary.
  + A reciprocating gait orthosis is not indicated due to the fact that it would restrict movement on the less involved side and as a result would inhibit dynamic balance reactions.

1. Would you make any changes to your recommendations based on your clinical reasoning discussed in the large group? What observation or piece of information affected your decision?

* Instructor guides discussion to reinforce key points described in question #4 for optimal orthotic selection.

1. What patient/family education topics should be addressed in order to promote success with the orthotic?

* Proper donning/doffing technique including stretching of the ankle plantarflexors prior to donning to ensure optimal positioning in AFO.
* Skin checks in order to prevent skin break down.
* A wearing schedule to build up wearing tolerance.
* Since the patient is receiving the orthotic upon discharge from inpatient rehabilitation, provision of the orthotist’s contact information in case the patient develops issues with fit or breakdown.
* Gait training and transfer training in order to optimize functional outcomes.

1. How will you know if the orthotic is appropriately fitting the patient?

* Improved functional abilities, best demonstrated by an objective outcome measure. For example, a measure of gait speed or balance with and without the orthotic
* Intact skin without signs of excessive pressure following gait training with new orthotic.
* Heel secure in the AFO with no excessive motion visualized when walking.

**Case #2**

**Guiding Questions for Small Group Discussion:**

1. What are the patient's primary impairments and functional limitations?
   * Primary Impairments: decreased LE strength (specifically in hip extensors, quadriceps, dorsiflexors, and greater weakness on left versus right LE), impaired balance responses and postural stability
   * Functional Limitations: requires at least stand by assist for basic functional mobility and gait, unable to perform age appropriate gross motor skills
2. What factors should you consider when deciding on an appropriate orthotic for this patient and why?
   * Postural observations during static standing and gait as poor alignment and joint stability will affect his balance responses and gait mechanics.
   * Overall muscle weakness that affects alignment, posture, functional mobility, and gross motor skills.
   * Goals for age-appropriate functional mobility and gross motor skills, as the type of orthosis may facilitate or inhibit performance of some of these skills.
3. What additional questions would you ask the patient/family when considering the most functional brace for the patient?
   * What are the family’s goals for his overall ability to perform functional mobility and gross motor skills?
   * What activities outside of PT does the child participate in?
   * Will the family be able to manage donning and doffing the orthotic in their daily routine, and will someone be able to assist him in school if needed?
4. At this point, what type of orthotic would you recommend and why?
   * A Dynamic ankle foot orthosis (DAFO) with moderately flexible posterior strut and wrap around ankle support to provide medial/lateral support at the ankle and control at the knee to prevent knee hyperextension during stance phase of gait. The moderately flexible posterior strut also assists with limb clearance during swing phase of gait and allows for some ankle motion while performing squat to stand, jumping, and stair climbing.

**Guiding Questions for Large Group Discussion:**1. What orthotics did you consider and how did you choose one over the other?

* + Based on student responses, compare and contrast orthotics and appropriateness of the recommendation.
  + Other possible recommendations:
  + A supramalleolar orthosis (SMO) may provide the needed medial/lateral support at the ankle, however, does not provide the control needed at the knee to prevent knee hyperextension in stance phase of gait.
  + A solid ankle foot orthosis would provide the needed support at the ankle and knee, however, it would limit his ability to perform floor mobility and gross motor skills such as squatting and jumping.
  + A hinged ankle foot orthosis would provide the needed support at the ankle and potentially at the knee if using a plantarflexion stop, however, his overall LE weakness indicates that he requires more stability in both flexion and extension.

2. Would you make any changes to your recommendations based on your clinical reasoning discussed in the large group? What observation or piece of information affected your decision?

* + Instructor guides discussion to reinforce key points described in #4 for optimal orthotic selection.

3. What patient/family education topics do you anticipate need to be addressed in order to promote success with the orthotic?

* + Proper donning/doffing technique.
* Skin checks in order to prevent skin break down.
* A wearing schedule to build up wearing tolerance.
  + Indications (such as persistent or excessive redness) to contact the orthotist for adjustments.
  + Additional training on transfers, gait, and stairs as he will likely require a different level of assist while adjusting to new orthotics.

4. How will you know if the orthotic is appropriately fitting the patient?

* Improved functional abilities, best demonstrated by an objective outcome measure. For example, a measure of gait speed or balance with and without the orthotic
* Intact skin without signs of excessive pressure following gait training with new orthotic.

**Case #3**

**Guiding Questions for Small Group Discussion:**

1. What are the patient's primary impairments and functional limitations?
   * Primary Impairments: paralysis in right LE with slight knee flexion contracture, decreased strength and motor control in left LE, leg length discrepancy, increased muscle tone in left UE resulting in decreased functional AROM
   * Functional Limitations: requires a 2 person transfer, decreased efficiency with household ambulation using KAFOs and posterior walker
2. What factors should you consider when deciding on an appropriate orthotic for this patient and why?
   * Paralysis and contracture in the right LE will require increased support when walking
   * Weakness and decreased motor control in left LE will also limit active participation in gait
   * Need for correction of leg length discrepancy and support of knee flexion contracture to maintain alignment.
   * Energy efficiency to improve overall quality and endurance for household ambulation. Currently uses trunk momentum to assist with functional movement of LEs.
   * Cognition and his ability to perform gait training while actively engaging LEs and managing posterior walker, as well as potential change of gait pattern with new orthotic recommendation.
3. What additional questions would you ask the patient/family when considering the most functional brace for the patient?
   * What are the family’s goals for his overall ambulation ability? What challenges are they currently facing with his KAFOs and posterior walker?
   * What is their home environment like? What is his school environment like? Will he have enough space in these environments to effectively ambulate and maneuver his walker?
   * Will the family be able to manage donning and doffing the orthotic in their daily routine, and will someone be able to assist him in school if needed?
4. At this point, what type of orthotic would you recommend and why?
   * A reciprocating gait orthosis because the patient continues to require significant support at all LE joints (which he is currently receiving from his KAFOs) to maintain weight bearing, and would benefit from the added level of assist provided to advance his LEs. He currently utilizes trunk momentum to advance his LEs which is not energy efficient to progress his functional gait. An RGO can also be customized to account for leg length discrepancy and knee flexion contracture.

**Guiding Questions for Large Group Discussion:**1. What orthotics did you consider and how did you choose one over the other?

Based on student responses, compare and contrast orthotics and appropriateness of the recommendation.

* + Other possible recommendation:
  + A hip knee ankle foot orthosis without reciprocating component will provide the patient with the level of support required at all joints to maintain alignment in weight bearing positions.

2. Would you make any changes to your recommendations based on your clinical reasoning discussed in the large group? What observation or piece of information affected your decision?

* + Instructor guides discussion to reinforce key points described in #4 for optimal orthotic selection.

3. What patient/family education topics do you anticipate need to be addressed in order to promote success with the orthotic?

* + Proper donning/doffing technique.
* Skin checks in order to prevent skin break down.
* A wearing schedule to build up wearing tolerance.
  + Indications (such as persistent or excessive redness) to contact the orthotist for adjustments.
  + Provide additional training on transfers and gait as the RGO will require different motor patterns to effectively perform each.

1. How will you know if the orthotic is appropriately fitting the patient?
   * Observed improvements in gait are noted, which may include cadence, distance, quality, level of fatigue.

* Intact skin without signs of excessive pressure following gait training with new orthotic.

**Case #4:**

**Guiding Questions for Small Group Discussion:**

1. What are the patient's primary impairments and functional limitations?

* Primary Impairments: Weakness on the right with more distal than proximal involvement
* Functional Limitations: Contact guard assist for gait with use of a single point cane

1. What factors should you consider when deciding on an appropriate orthotic for this patient and why?

* Significant ankle weakness that will require assistance for lower extremity clearance during swing phase of gait.
* No spasticity is a positive factor and allows options for an articulating or flexible type of AFO
* Affordability of the orthotic and type of insurance coverage
* Intact sensation is helpful in order to prevent skin breakdown
* Will the patient be able to independently don/doff the orthosis?

1. What additional questions would you ask the patient/family when considering the most functional brace for the patient?

* Is the patient open to using an orthotic? This patient had concerns regarding the esthetics of the brace. Therefore, she was only open to wearing a brace that could be hidden under her pants.
* Are there any family members who will be able to assist in donning/doffing an orthotic once she discharges?
* Does she have any pain during mobility?

1. At this point, what type of orthotic would you recommend and why?

* A carbon fiber off the shelf AFO may be ideal for this patient given the sleek black features that may appeal to the patient’s preference for an esthetically pleasing brace. It also provides a dorsiflexion assist while at the same time being financially appealing from the perspective of being an off the shelf product.

**Guiding Questions for Large Group Discussion:**

1. What orthotics were you deciding between and what made you choose one over the other?

* Based on student responses, compare and contrast orthotics and appropriateness of the recommendation
* Other possible recommendations:
  + An articulating AFO with a dorsiflexion assist may be appropriate for the patient’s impairments. However, it is a custom brace that is more costly and is more cumbersome for the patient in terms of weight and fit. The patient’s impairments also do not indicate the need for increased medial/lateral stability of the ankle joint.
  + If this patient presents with knee hyperextension due to poor co-activation at the knee and plantarflexor weakness, an articulating AFO would then also require a plantarflexion stop in order to inhibit the knee hyperextension. The carbon fiber AFO may provide enough knee stability if the knee hyperextension is mild.

1. Would you make any changes to your recommendations based on your clinical reasoning discussed in the large group? What observation or piece of information affected your decision?

* Instructor guides discussion to reinforce key points described in question #4 for optimal orthotic selection

1. What patient/family education topics do you anticipate need to be addressed in order to promote success with the orthotic?

* Proper donning/doffing techniques.
* Skin checks in order to prevent skin break down.
* A wearing schedule to build up wearing tolerance.
* Since the patient is receiving the orthotic upon discharge from inpatient rehabilitation, provision of the orthotist’s contact information in case the patient develops issues with fit or breakdown.
* Gait training and transfer training in order to optimize functional outcomes.

1. How will you know if the orthotic is appropriately fitting the patient?

* Improved functional abilities, best demonstrated by an objective outcome measure. For example, a measure of gait speed or balance with and without the orthotic
* Intact skin without signs of excessive pressure following gait training with new orthotic.
* Heel remains securely in the ankle foot orthosis with no excessive motion visualized during walking

Time for student to complete the activity: preparation for activity outside of/before class: 1 hour to review background reading or recorded lecture, complete study guide and review videos; class time completion of the activity: 1 hour and 40 minutes total (broken down into two 50 minute blocks with a 10 minute break in between)

Readings/other preparatory materials:

1. View the pre-recorded lecture labeled:  Prep Assignment for Orthotics Class.  OR

2. Complete the assigned reading: Edelstein JE, Wong CK. Orthotics. In: O’Sullivan SB, Schmitz TJ, Fulk GD. Physical Rehabilitation. 6th ed. 2014. F.A. Davis Company, Philadelphia, PA. 1325-1360

(Note: The instructor selects to provide the students with the pre-recorded lecture OR to assign a reading from a text. Both activities are not required tasks in order to prevent overburdening the students.)

Learning Objectives:

1. Describe the physical therapist’s role in orthotic selection when given a patient case.
2. Compare and contrast the indications and contraindications of different lower extremity orthoses.
3. Apply clinical reasoning skills to determine malfunctions in orthoses which necessitate their removal.
4. Apply clinical reasoning skills to select the most appropriate lower extremity orthosis based on gait findings for a given patient case.

Methods of evaluation of student learning:

A classroom assessment technique (CAT) can be utilized to assess learning for this specific learning activity. A recommended option would be asking the students to submit to the instructor, either via paper or an electronic option, what the muddiest point is following completion of the case discussions. Based on the responses, the instructor can then follow up with the class to clarify any remaining concepts that need to be reinforced. The instructor may also choose to develop multiple choice examinations or essay questions in order to further assess student learning.