Design Phase of Instructional Design Model

Mai Yang Xiong

California State University, San Bernardino

ETEC 644 – Spring 2016

**Project Name:** AP Calculus AB Review: Linear Motions

**Project Description**

The focus for this project is to develop review material to prepare AP Calculus AB high school students for the AP exam. The project goal is AP Calculus AB high school students will have a better understand of integral concepts for the AP exam, by participating in re-teaching of concept and procedures on applying definite integrals to problems involving motion in a classroom setting.

The sub-goals for this project was developed based on the learning objective and essential knowledge in the *AP Calculus AB and AP Calculus BC: Course and Exam Description* (2016). The sub-goals are:

Sub-Goal 1: AP Calculus AB high school students will calculate the displacement of a particle in rectilinear motion over an interval of time, using the definite integral of velocity.

Sub-Goal 2: AP Calculus AB high school students will calculate the total distance of a particle in rectilinear motion over an interval of time, using the definite integral of speed.

Sub-Goal 3: AP Calculus AB high school students will determine the position of a particle in rectilinear motion over an interval of time, using the definite integral.

Due to time constraint in creating this project, Sub-Goal 3 will be the focus for my project.

**Instructional Objectives**

The learning objectives for this project corresponds to the sub-goals, respectively. The learning objectives for this project are as follow:

LO 1: Given the velocity (in a table, graph, or equation) of a particle in rectilinear motion over an interval of time, students will be able to write and evaluate a definite integral of velocity to calculate the displacement, with 75% accuracy on the end of the lesson's assessment.

LO 2: Given the velocity (in a table, graph, or equation) of a particle in rectilinear motion over an interval of time, students will be able to write and evaluate/approximate a definite integral of speed to calculate the total distance, with 75% accuracy on the end of the lesson's assessment.

LO 3: Given the velocity (in a table, graph, or equation) of a particle in rectilinear motion over an interval of time, students will be able to write and evaluate an expression involving definite integral to calculate the position of a particle at a given time, with 75% accuracy on the end of the lesson's assessment.

Since my project will only focus on sub-goal 3, then corresponding learning objective will be LO 3.

**Instructional Content Structure**

The content for this project will be review and delivered in 3 short videos. The content in the first video is as follow:

* the concept of velocity: or
* the concept of displacement over an interval: measures the change in position or
* how to calculate displacement over an interval(integral of velocity):

The content in the second video is as follow:

* the concept of speed: velocity with no direction or
* and total distance traveled: measures all the distance traveled
* how to calculate total distance traveled over an interval(integral of speed):

The content in the third short video is as follow:

* Fundamental Theorem of Calculus
* Displacement definition and concept (integral of velocity)
* the concept of a particle in rectilinear motion (particles moving in a line)
* how find position of a particle in rectilinear motion using the Fundamental Theorem of Calculus:

For my project, only the third video will be developed because it corresponds with sub-goal 3 and learning objective 3.

**Motivation Strategies**

To gain and maintain AP Calculus AB high school students’ attention in reviewing for the AP Calculus exam, Keller’s ARCS Model will be applied. ARCS model stands for Attention, Relevance, Confidence, and Satisfaction (What are the ARCS Categories?). This lesson can provide students with both intrinsic and extrinsic motivation. Student will find it rewarding because they will be reviewing skills and concepts that they already know, but need more practice, and with the goal of earning a score of 3 or higher (which can earn them college credit for the course) for the exam.

To get the students’ attention, this lesson will utilize variability. The instructor will state and display the learning objective. A short video lecture will be used to review the concepts and procedures on applying definite integrals for calculating velocity, total distance, and position of a particle in rectilinear motion over an interval of time. To maintain students’ attention, past AP multiple choice and free response questions will be given to students to practice individually first and then merge into pairs or group. Relevance will be established by informing the students how the concept of integral is going to be assess on the exam. Furthermore, released free response and past multiple choice questions related to the topic will be utilized as practice problems to maintain relevance and build students’ confidence. Using past AP materials for review can be beneficial because students will know and be familiar with how the topic is assess and the scoring guide for the free response will be used to provide student feedback on their performance and understanding of the concept. Students can use the scoring guide to evaluate their strengths and weaknesses. The past AP materials can also provide student with satisfaction in preparation for the exam because they will be able to use their skills and knowledge of the concept apply it to the appropriate level of rigor that will be expected on the actual exam. In addition, students will be satisfied with the structure of working individually on review problems and then in pairs or groups because this type of structure was what they had suggested.

**Media Selection**

Media that will be used in this project will be short videos and handouts of examples and practice problems (multiple choice and free response). The short video for this project will be developed using iMovie. It will be shared to YouTube and a link will be posted on the class website for students to access.

The short videos will review the concepts of velocity, total distance, and position of a particle in rectilinear motion. Video is chosen as the media for delivering the concept because in addition to classroom delivery method, two students indicated on their survey an interest in having short videos to deliver content and the instructor had already provided direct instruction on this concept during the school year. Thus a video would get the students’ attention and is a different method in presenting the topic.

According to Chinnappan and Chandler (2010) and Ayres (2006), teachers need to be conscious of high intrinsic and extraneous load task because high cognitive load can reduce mental resources for developing schemas. The videos will review concepts and procedures which gives students who were struggling with the concept and skills to make connections and correct any misinterpretations they may have. Ayres (2006) also suggested to lower cognitive load task by minimizing complexity of problems. As a result, for this project there are three separate short videos, each focusing on only one concept at a time. Following each video, practice problems will be given for students to practice.

The handouts of examples and practice problems will be used for students to write or take notes on because the actual exam will be paper and pencil. The examples and practice problems will be developed from released AP Calculus free response and multiple choice questions. These resources are available from the AP Calculus AB website. Providing handouts rather than have students take notes separately in their notebook can reduce high extraneous load task. The handouts contain the question and table, graphs, or equation that allow students to write or mark up the questions, tables, graphs, or equations directly. Students’ work and notes can be integrated onto the examples in the handout and reduce split-attention effect (Sweller, 2002).

**Practice Activities & Feedback Strategies**

In this project students will be given opportunities to practice the skills that goes with the concepts reviewed in the short videos. Released AP multiple choice and free response questions will be used as practice problems. A minimum of 2 multiple choice questions and 2 free response questions will be given for students to practice the skills and procedures per learning objective (a total of 12 practice problems). Dobbins, Gagnon, and Ulrich (2014) suggest the use of graduated and peer-mediate instruction to assist students with difficulty in math. For this project, I have considered to incorporate the use of peer-mediate instruction to assist the students in reviewing because there are some students who are really struggling with the concepts and skills. Lower performing students will be paired with higher performing students. Each student will be given think time by first work individually on a practice problem. Then they will then collaborate with the other students by taking turns coaching and practicing the content materials. Students will be able to practice the math skills and procedures and get instant feedback about their work. The instructor will also provide solutions a head of time and give it the entire class, upon completion of practice problems, so students can monitor their progress in learning the concepts and procedures, and mistakes they are making.

Upon completion of the practice problems, students will summarize how to find the position of a particle at a given time using the Fundamental Theorem of Calculus. Providing opportunity for summary gives students a chance to organize and sequence concepts they’ve learn. From a constructivist perspective summarizing promotes processing of information and transfer of knowledge (Ertmer & Newby, 2013)

**Assessments**

A pretest will not be administered because a practice mock AP exam was already given. The practice mock exam revealed that integral concept was the weakest out of the three topics in the course. A posttest will be administered at the end of the lesson. Due to time constraint, the assessment will only be free response so the instructor can evaluate students’ work. The questions are adapted from the past AP Calculus AB free responses. See Appendix A for the posttest. Each problem will be graded based upon the scoring guide from the College Board, where students will be given points for each component of solution to the problem.

**Timeline for Development**

1. Create post assessment

2. Develop a lesson plan.

3. Create storyboard for video 3.

4. Organized multiple choice and free response topics relating to the integral concept of particle in linear motion to create a packet of handout.

5. Modify (if necessary) multiple choice and/or free response topic relating to the integral concept of particle in linear motion, if necessary, to create a packet of handout.

6. Record video.

7. Edit Videos.

8. Develop handouts.

9. Share Video on YouTube

10. Add a page on class website

11. Add handouts and link to video on class website.

**Instructional Flow Chart**

See Appendix B for the instructional flow chart.

**Summary**

In this project, I will be developing review materials for AP Calculus AB students to prepare for the AP exam. The topic that will be covered is particles in rectilinear motion and calculating the position of the particle at a given time. The lesson will be delivered in a classroom setting, with the use of video and handouts. Students will be reviewing and practicing skills and procedures related to the topic. At the end of the lesson, students will take a posttest.

**References**

*Ap calculus ab and ap calculus bc: Course and exam description*. (2016). New York, NY: CollegeBoard.

Ayres, P. (2006). Impact of reducing intrinsic cognitive load on learning in a mathematical domain. *Applied Cognitive Psychology, 20*, 287-298.

Chinnappan, M., & Chandler, P. (2010). Managing cognitive load in the mathematics classroom. *Australian Mathematics Teachers, 66*(1), 5-11.

Dobbins, A., Gagnon, J. C., & Ulrich, T. (2014). Teaching geometry to students with math difficulties using graduated and peer-mediated instruction in a response-to-intervention model. *Preventing School Failure, 58*(1), 17-25. doi:10.1080/1045988x.2012.743454.

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly, 26*(2), 43-71. doi:10.1002/piq

Sweller, J. (2002). Visualisation and instructional design. In *Proceedings of the International Workshop on Dynamic Visualizations and Learning*. 1501-1510.

What are the ARCS Categories? (n.d.). Retrieved May 2, 2016 from http://www.arcsmodel.com/#!arcs-categories/c1zqp

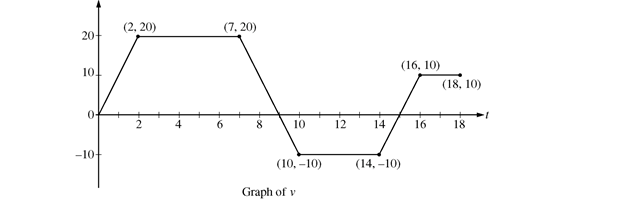
College Board (2010). 2010 AP Calculus AB free-response questions (form b). Retireved from http://apcentral.collegeboard.com/apc/public/repository/ap10\_frq\_calculus\_ab\_formb.pdf

College Board (2011). 2011 AP Calculus AB free-response questions (form b). Retrieved from http://apcentral.collegeboard.com/apc/public/repository/ap11\_frq\_calculus\_ab\_formb.pdf

College Board (2013). 2013 AP Calculus AB free-response questions. Retrieved from http://media.collegeboard.com/digitalServices/pdf/ap/apcentral/ap13\_frq\_calculus\_ab.pdf

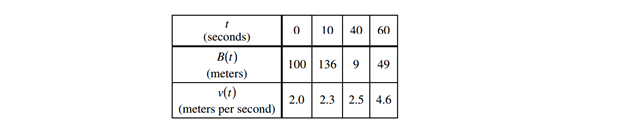
Appendix A: End of lesson assessment.

Adapted from 2010 AP Calculus AB Free-Response Question (Form B) Question 4 (No Calculator)



2. A squirrel starts at building at time and travels along a straight, horizontal wire connected to building . For , the squirrel’s velocity is modeled by the piecewise-linear function defined by the graph above. Write an expression involving an integral that gives the position of the squirrel . Use this expression and the graph to find the position of the squirrel at time .

Adapted from 2011 AP Calculus AB Free-Response (Form B) Question 5 (No Calculator)



3. Ben rides a unicycle back and forth along a straight east-west track. The twice-differentiable function models Ben’s position on the track, measured in meters from the western end of the track, at time , measured in seconds from the start of the ride. The table above gives values for and Ben’s velocity, , measured in meters per seconds, at selected times . Use the table to find Ben’s position at time .

2013 AP Calculus AB Free Response Question 2 (Calculator active)

1. A particle moves along a straight line. For , the velocity of the particle is given by , and the position of the particle is given by . It is known that . Write an expression involving an integral that gives the position of the particle. Use this expression to find the position of the particle at time .

Appendix B: Instructional Flow Chart

3. Use video to stimulate recall of prior learning

2. State the learning objective for the lesson.

1. Gaining attention by talking about the AP Exam and preparation for it.

5. Provide learning guidance by modeling how to apply the concept to free response questions.

6. Students work on practice problems individually first & then collaborate w/ partner (peer-mediate instr.)

4. Present the packet/handout of past review AP multiple choice and free response.

9. Enhance retention & transfer: working practice AP problems, summarize how to find position of objects.

8. Assessing the performance w/ end of lesson assessment

7. Provide feedback about performance in pairs (peer mediate instr. & instructor displaying solution/scoring guide)