The Software Framework for C₃PO: (Customizable Computer Coaches for Physics Online)

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Supported by NSF DUE-1226197 and the University of Minnesota.
Overview

• Written in Adobe Flash, consists of two graphical user interfaces (GUI):
Program Structure

• Three types of coach building blocks:
  – primitives, visual elements, & modules
Physics Exercise

What is the speed at which the Moon orbits the Earth?
Primitives

- Earth
- Moon
- $M_{\text{earth}}$
- $M_{\text{moon}}$
- $R_{\text{moon}}$
- $V_{\text{moon}} = ??$
- Dynamics
- Instant at which moon orbits earth.
- Earth + Moon System
- Gravitational Force
- Centripetal Force
- Orbital Velocity of Moon
Primitives

- Components of a written solution:
  - Objects, Quantities, Approaches, Systems, Assumptions, Equations, etc.

\[ \text{Earth} = 5.98 \times 10^{24} \text{ kg} \]

\[ \text{Moon} = 7.34 \times 10^{22} \text{ kg} \]

\[ G = 6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2} \]

\[ R_{\text{moon}} = 385,000 \text{ km} \]

\[ M_{\text{moon}} = 7.34 \times 10^{22} \text{ kg} \]

\[ V_{\text{moon}} = ?? \]

Dynamics

\[ \vec{F}_{\text{net}} = m\vec{a} \]

Neglect interactions with sun and other planets.

\[ F_G = \frac{Gm_1 m_2}{r^2} \]

\[ a_c = \frac{v^2}{r} \]
Visual Elements

Instant at which moon orbits earth.

\[ V_{\text{moon}} \]

\[ a_c \]

\[ F_g \]

\[ M_{\text{moon}} \]

\[ M_{\text{earth}} \]

\[ R_{\text{moon}} \]
Visual Elements

Visual representation of the primitives
Modules

Navigator

- Focus the Problem
- Picture(s)
- Which object(s)?
  - Situations and views
  - Quantities
  - Question(s)
  - Assumption(s)
  - Approach(es)
- Describe the Physics
  - Define Diagrams
  - Target Quantities
  - Quantitative Relation
- Plan the Solution
- Execute the Plan
- Evaluate the Solution

Word Problem

Instant at which moon orbits earth.

Diagram:

- $V_{moon}$
- $a_c$
- $M_{moon}$
- $M_{earth}$
- $F_g$
- $R_{moon}$
Modules

Parent-child relationships of Folders, Questions & Actions

Student’s path is not fixed.
Actions

– Actions can be used to move the program forward and change the state of the coach

  • The principle action is unlocking a building block of the coach, for example:
    – Unlocking a visual element makes it visible
    – Unlocking a primitive allows that primitive to be accessible
    – Unlocking a module allows questions contained within to be viewed

– Actions give the coach flexibility

  • Students can be fully constrained to answer questions in a certain order OR students can choose the order
  • Students can choose the amount of coaching they receive
Example: Unlocking a primitive

We often need a visual representation of the problem to help organize a problem. Which object(s) do you wish to represent in a picture of the problem?

Choose all appropriate answers below.

- Earth
- Moon
- Yourself

Instant at which moon orbits earth.
Example: Check whether primitives have been unlocked
Demonstration

- Student creates a diagram from a picture